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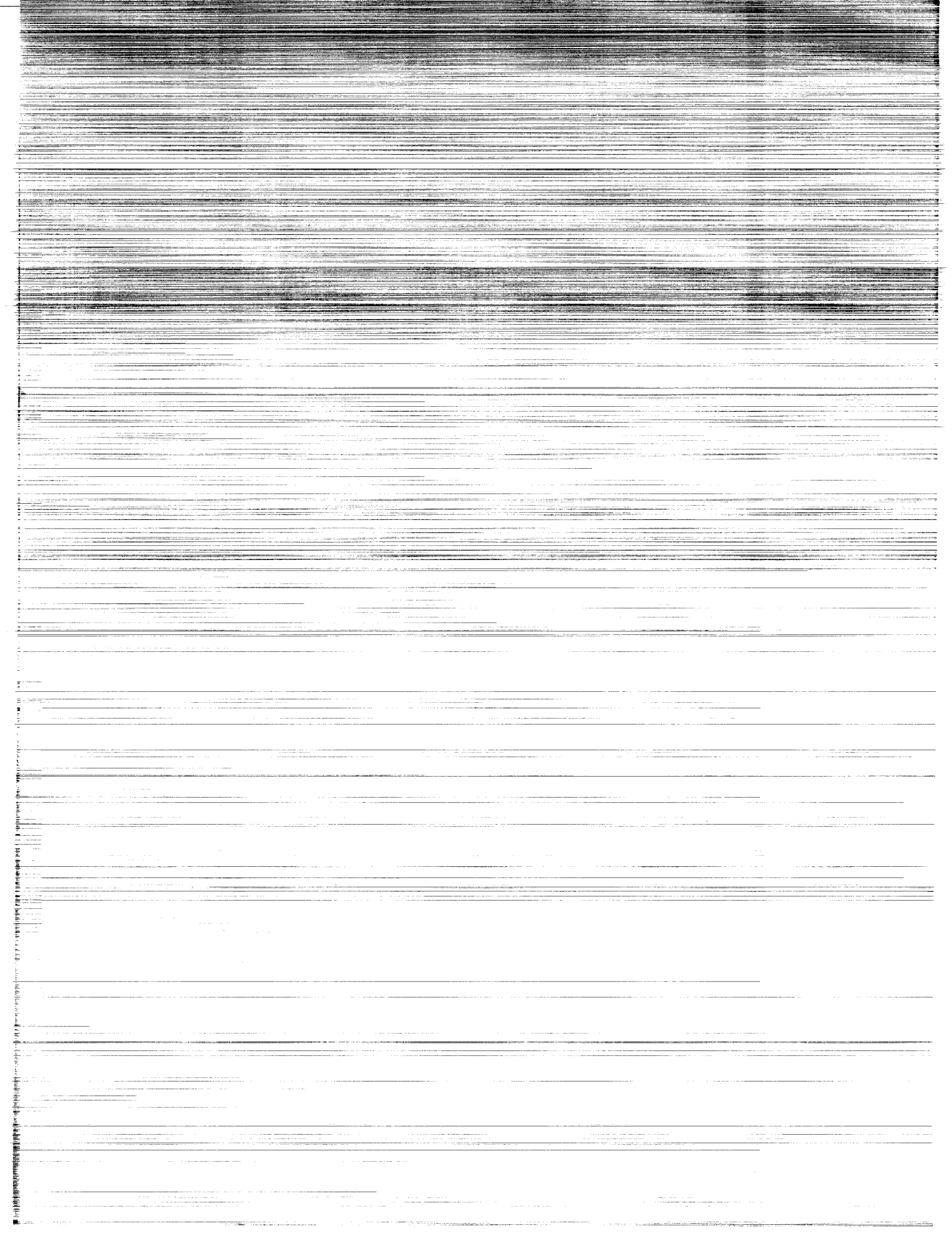
**NASA Contractor Report 3716**

**A Summary and Integration of  
Research Concerning Single Pilot  
IFR Operational Problems**

**G. Courtney Chapman**

**GRANT NAG1-238  
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# **NASA Contractor Report 3716**

## **A Summary and Integration of Research Concerning Single Pilot IFR Operational Problems**

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**Prepared for**  
**Langley Research Center**  
**under Grant NAG1-238**



National Aeronautics  
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## TABLE OF CONTENTS

INTRODUCTION.....	1
OBJECTIVE.....	2
METHODOLOGY.....	3
ANALYSIS AND DISCUSSION.....	4
KEY ISSUES.....	4
A. SKILL/PROFICIENCY/DECISION MAKING/TRAINING.....	4
B. WEATHER/CONDITIONS OF LIGHT.....	5
C. ATC/COMMUNICATIONS/PROCEDURES/NAV AIDS .....	5
D. WORKLOAD/DISTRACTION.....	6
E. COCKPIT ENVIRONMENT/AIRCRAFT CONTROL.....	6
F. AIRCRAFT SEPARATION.....	6
RESEARCH ADDRESSING KEY ISSUES.....	6
A. SKILL/PROFICIENCY/DECISION MAKING/TRAINING.....	7
B. WEATHER/CONDITIONS OF LIGHT.....	8
C. ATC/COMMUNICATIONS/PROCEDURES/NAV AIDS.....	8
D. WORKLOAD/DISTRACTION.....	9
E. COCKPIT ENVIRONMENT/DISPLAY/AIRCRAFT CONTROL.....	9
F. AIRCRAFT SEPARATION.....	9
CONCLUDING REMARKS.....	10
APPENDIX 1.....	1-1
PURPOSE/OBJECTIVE SUMMARY.....	1-1
APPENDIX 2.....	2-1
METHODOLOGY SUMMARY.....	2-1
APPENDIX 3.....	3-1
RESULTS SUMMARY.....	3-1

APPENDIX 4.....	4-1
RECOMMENDATIONS/RESEARCH SUMMARY.....	4-1
APPENDIX 5.....	5-1
INTEGRATION AND COMPARISON.....	5-1
A. RATINGS.....	5-1
B. TRAINING.....	5-1
C. EXPERIENCE.....	5-3
D. PILOT SKILL, PROFICIENCY, DECISION MAKING.....	5-6
E. WORKLOAD/DISTRACTION.....	5-9
F. WEATHER/CONDITION OF LIGHT.....	5-10
G. AIR TRAFFIC CONTROL.....	5-13
H. SAFETY, EFFICIENCY, RELIABILITY.....	5-14
I. AIRCRAFT.....	5-16
J. AIRPORT.....	5-17
REFERENCES.....	6-1

## ABBREVIATIONS

ADF	Automatic Direction Finding
AM	Anti meridiem; before noon
ARTCC	Air Route Traffic Control Center
ASRS	Aviation Safety Reporting System
ATARS	Automated Traffic Advisory and Resolution Service
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATP	Airline Transport Pilot
ATX	Air Taxi
BFR	Biennial Flight Review
BUS	Business
CAS	Collision Avoidance System
CHR	Charter
COM	Commercial
COM	Communications
CORP	Corporate
DME	Distance Measuring Equipment
EFAS	En Route Flight Advisor Service
FAA	Federal Aviation Administration
FRT	Freight
FSS	Flight Service Station
GA	General Aviation
HI	High
HUD	Heads Up Display
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LOC	Localizer
MAX	Maximum
MED	Medium
MEP	Multiengine Piston
MIN	Minimum
MVFR	Marginal Visual Flight Rules
NAFEC	National Aviation Facilities Experimental Center
NASA	National Aeronautics and Space Administration
NAV	Navigation
NM	Nautical Miles
NTSB	National Transportation Safety Board

PATWAS	Pilots Automatic Telephone Weather Answering Service
PAX	Passenger
PER	Personal
PVT	Private
PWI	Proximity Warning Indicator
RNAV	Area Navigation
SEP	Single Engine Piston
SMA	Small Aircraft
SMT	Small Transport
SPIFR	Single Pilot Instrument Flight Rules
TBP	Turboprop
TCA	Terminal Control Area
TSD	Traffic Situation Display
TV	Television
TWEB	Transcribed Weather Broadcasts
US C&GS	United States Coast and Geodetic Survey
VASI	Visual Approach Slope Indicators
VFR	Visual Flight Rules
VOR	Very High Frequency Omni Range

## INTRODUCTION

The National Aeronautics and Space Administration (NASA) is conducting research to provide background research and to develop the technology to improve the safety and utility of General Aviation (G.A.) Single Pilot Instrument Flight Rules (SPIFR) operations. In order to more effectively and efficiently utilize available resources, operational and problem definition studies performed by both the NASA and other agencies are being used to assist in directing the NASA research effort.

The following are recent studies that have investigated the nature and dimensions of the SPIFR operation and the problems experienced. <sup>1</sup>

- R1. Weislogel, G.S.; and Miller, J.M.: Study to Determine the Operational Profile and Mission of the Certificated Instrument Rated Private and Commercial Pilot. Report No. FAA-RD-70-51, 1970.
- R2. Forsyth, Donna L.; and Shaughnessy, John D.: Single Pilot IFR Operating Problems Determined from Accident Data Analysis. NASA TM-78773, 1978.
- R3. Bolz, Eric H.; and Eisele, Janice E.: General Aviation IFR Operational Problems. NASA Contractor Report 159022, 1979.

<sup>1</sup>

Abbreviations used in this report are found beginning on page iii. For the readers ease of reference, information that is extracted from a report and presented in the body or appendices of this report, may be referred to by report No. (R-  ); page number (p-  ); paragraph No. (para-  ) or a combination as appropriate.

- R4. Bergeron, Hugh P.: Analysis of General Aviation Single - Pilot IFR Incident Data Obtained From the NASA Aviation Safety Reporting System. NASA TM 80206, 1980.
- R5. Weislogel, Stacy: Operational Problems Experienced by Single Pilots in Instrument Meteorological Conditions. NASA CR 166236, 1981.
- R6. Weislogel, G.S.: Study To Determine the IFR Operational Profile and Problems of the General Aviation Single Pilot. NASA CR 3576, 1983.
- R7. Harris, D.F.; and Morrisette, J.A.: Single Pilot IFR Accident Data Analysis. NASA CR-3650, 1982

### OBJECTIVE

The objective of this study was to develop an overview document that summarizes, makes comparisons, identifies key issues and common findings, and integrates the results of SPIFR operational problems research found in the seven studies.

### METHODOLOGY

The reports were reviewed to determine those aspects of commonality that could be analyzed and correlated. The sections of the seven reports that were considered relevant to this study were the objective, methodology, results, and recommendations. These data were analyzed and integrated, and are presented in appendices 1-4. The results were disaggregated into similar subject areas. (See appendix 5). The key issues and recommended research addressing these key issues/problems were summarized and

are presented in the analysis and discussion section. The specific steps, as they relate to the organization of the report, are given below.

- . Extract the statement of purpose and/or objective of each study. (See Purpose/Objective Summary - Appendix 1)
- . Summarize the methodology used by each researcher. (See Methodology Summary - Appendix 2)
- . Assemble the conclusions; results and/or findings from each study. (See Results Summary - Appendix 3)
- . When specified, gather the recommended research from the analysis of a study. (See Recommendations/Research Summary - Appendix 4)
- . Disaggregate the findings from individual reports and reaggregate to integrate them into similar subject areas. (See Integration and Comparison - Appendix 5)
- . List and discuss key issues that emerge from the reports. (Analysis and Discussion)
- . Identify the recommended research that will address the problems noted. (Analysis and Discussion)

## ANALYSIS AND DISCUSSION

### KEY ISSUES

A review of the integration and comparison of conclusions and findings of the seven reports, appendix 5, identified key issues in SPIFR operations. The key issues are synthesized below and are assembled under six rather broad subject areas. Any change or improvement in one area usually affects the SPIFR operations in another area. Thus a key issue may not be a "stand alone" concern, but inter-related to other activities in SPIFR operations.

A definite consistency exists in the characteristics of the 'composite' or 'average' pilot as described by the studies using questionnaires, NTSB reports, and ASRS reports. Since there are no real conflicting comparisons, it is suggested (not proven) that the "real world" is being sampled in these studies.

The following is a summary of the key issues that emerged from the review.

#### A. Skill/Proficiency/Decision Making/Training

- . Statistics of accidents on final approach where the aircraft is under control and has a collision with a stationary object on the ground suggests that the pilot: 1) may not be proficient at flying the aircraft, 2) has had inadequate training, or 3) cannot recognize and make timely corrections to positional deviations (particularly at night).
- . Reported incidents confirm frequent pilot deviations in altitude, heading and position, and improperly flown approaches, improper holding procedures, and below minimum operations.
- . Pilots report difficulties in maintaining recency of experience thus allowing their proficiency to deteriorate.
- . Future complex and sophisticated ATC procedures, and new complex and sophisticated aircraft will require extensive pilot training to update to these new systems and equipment.
- . The pilot's judgment and decision making process, including the ability to plan ahead and the ability to assess his/her own capabilities and limitations, needs improvement.

## B. Weather/Conditions of Light

- . A need exists for improvements in the process of obtaining weather information.
- . Preflight planning and in-flight weather updates are similar in the kinds of information required.
- . Weather information is desired that is timely, is reliable, pilots have confidence in, and eliminates unforeseen and unanticipated weather encounters.
- . The forecasting and reporting of thunderstorms and icing are of particular importance. SPIFR pilots consider icing and thunderstorms to be most threatening experiences in flight. Ice is identified as a contributor to a significant number of SPIFR accidents.
- . Pilots did not emphasize or note any shortcomings in reporting of low ceilings and fog, but their importance is manifested in approach accidents that increase as visibility decreases.
- . Relatively, there are significantly more accidents at night than during the day. This suggests that pilots should have more familiarity and training in night operations.

## C. ATC/Communications/Procedures/Nav Aids

- . Communications, the exchange of information, is a consistent subject throughout the reports. Part of the communications problem is understanding what is being said and intended by both the Air Traffic Controllers and the Pilots.
- . Part of the communications problem is the workload on the pilot. Workload can come from having to speak, making a frequency change, or performing in response to an ATC instruction.
- . Some of the present and anticipated future Air traffic control operations and procedures are complex and involved.
- . Some of the communications problems include ATC intra-facility and inter-facility exchanges that impact on the SPIFR flight.
- . Information required for flight planning, its availability, and its ease of use is a concern to the SPIFR pilot.

#### D. Workload/Distracton

- . A heavy workload for a SPIFR Pilot can be simply an annoyance or it can end in a catastrophic event. Weather, ATC, and aircraft complexities all impact on workload.
- . Excessive workload may be a contributor to the problems of position deviations, misunderstood communications, or fuel systems mismanagement.
- . Workload can result in distractions from a principle task which leads to deterioration in performance.
- . Workload is of additional concern as IFR traffic in the future may increase and the ATC procedures may become more complex and demanding.

#### E. Cockpit Environment/Displays/Aircraft Control

- . Pilots complain of inadequate lighting in the cockpit/cabin area and of a noisy cockpit environment. Lighting contributes to the pilot's ability to read/obtain information from charts at night while noise contributes to the level of fatigue.
- . Other areas of concern are the instrument panel/controls arrangement and design, and the use of flight directors and/or autopilots.

#### F. Aircraft Separation

- . The task of maintaining aircraft separation in high density areas and of reducing the potential for VFR/IFR conflicts are goals that permeate other considerations.

### RESEARCH ADDRESSING KEY ISSUES

Some of the key issues identify existing or potential problems of SPIFR operations. The authors of some of the reports have suggested general areas that need to be investigated to solve these problems or prevent future problems from arising.

The authors have also identified several relevant considerations that need to be addressed in deciding on the research to be performed. The following are three examples.

- . "research aimed at solving these problems must emphasize low cost, low volume, low weight equipment, and human factors considerations." (R. 2, p. 19)

- . "a major theme that is expressed, or is evident, in all the ASRS data is the frequent involvement of human error in the incidents reported." (R. 4, p.3, para. 3)
- . "Further detailed analysis of the survey data can provide additional insight into the nature of the GA SPIFR and his operational problems..... (R. 6, p. 24)

These three quotes emphasize three important factors relevant to SPIFR research: the economics of solutions are important; human factors weaves its way throughout the SPIFR problems; and more research can be done on the data already collected.

The specificity of an investigation or research task recommended varies considerably between reports. This is primarily due to the different data sources, i.e. accident data, incident data, questionnaire response data, and interviews, used in the different reports. In order to keep intact the flavor of each author, the recommendations recorded in this section are in their original form.

The following quotes are used to specify the recommended research or research areas to address the key issues noted earlier.

A. Skill/Proficiency/Decision Making/Training

- . Better methods for pilots to safely acquire experience and increase proficiency (R. 2, p. 20)
- . More effective pilot training methods (R. 2, p. 20)
- . Enhance IFR Training Programs (R. 3, p. 5-12)
- . Pilot judgment and response problems (R. 4, p. 12)
- . Pilot Judgment and Decision Making - Improve pilot's ability to plan ahead - improve pilot's ability to more accurately assess his own capabilities and limitations (R. 6, p. 24)
- . The impact of simulated instrument time upon the likelihood of a SPIFR accident. Specifically, one would very much like to know how much impact reporting procedures in the NTSB accident briefs effect the statistics discussed in this report relating to simulated instrument time. Why are the levels of simulated instrument time that appear for the SPIFR pilots in the NTSB data base and the Ohio State survey as diverse as they are? (R. 7, p. 42)

B. Weather/Conditions of Light

- . New types of deicing or anti-icing equipment (R. 2, p. 20)
- . Better cockpit displays of weather information (R. 2, p. 20)
- . Develop Remote Weather Display concepts (R. 3, p. 5.6)
- . Weather Information - improve availability, reliability and timeliness (especially with respect to icing and thunderstorms) (R. 6, p. 24)
- . The disparity between day and night SPIFR accident rates. Out of 5,416 SPIFR accidents from 1964 to 1975 which involved pilot error, only 14 percent occurred at night. Based upon our estimate of night time activity (12.8 percent of overall activity) derived from the "General Aviation Pilot and Aircraft Activity Survey", it appears that SPIFR accident rates are unaffected by the condition of light while SPIFR approach/landing phase accident rates are magnified by 10 fold (R. 7, p. 42)

C. ATC/Communications/Procedures/Nav Aids

- . Low/Medium frequency receivers which can give on-course information (R. 2, p. 20)
- . Standardized and human factors designed navigation instrument displays (R. 2, p. 20)
- . Low-altitude warning systems (R. 2, p. 20)
- . Area Coverage Systems for Non-Precision Aids (R. 3, p. 5-10)
- . Efficient Route Reorganization of RNAV (R. 3, p. 5-14)
- . Requirements of Automated and Remote Towers (R. 3, p. 5-8)
- . Innovative Communications Procedures (R. 3, p. 5-13)
- . Alternative Precision Landing Aids (R. 3, p. 5-9)
- . Advanced HUD, VASI and Approach Monitor concepts (R. 3, p. 5-11)
- . Assess Data Link Avionics Requirements (R. 3, p. 5-7)

- . ATC and pilot communication problems (R. 4, p. 12)
- . Controller judgment and response problems (R. 4, p. 12)
- . ATC intrafacility and interfacility conflicts (R. 4, p. 12)
- . Communications - minimize communications workload (R. 6, p. 24)
- . Instrument approaches - revise ATC procedures to minimize pilot workload (R. 6, p. 24)

D. Workload/Distractation

- . Improved fuel management systems (R. 2, p. 20)
- . Improved air-to-ground communications which would reduce pilot workload (R. 2, p. 20)
- . Workload - Optimize wherever feasible (R. 6, p. 24)

E. Cockpit Environment/Display/Aircraft Control

- . Cockpit displays of aircraft position on area mapping (R. 2, p. 20)
- . Improved basic aircraft stability and control (R. 2, p. 20)
- . Configuration Control and Display Integration (R. 3, p. 5-1)
- . Develop Distributed Management/Traffic Situation Display Concepts (R. 3, p. 5-4)
- . Cockpit Environment - Better lighting - Better noise protection (R. 6, p. 24)

F. Aircraft Separation

- . Promote Collision Avoidance System Proximity Warning Indicator Development (R. 3, p. 5-3)
- . IFR-VFR conflicts (R. 4, p. 12.)

## SUMMARY AND CONCLUDING REMARKS

The review and analysis of the seven studies resulted in both expected and unexpected results. As expected, the major problem areas, as defined in the individual reports, were generally corroborated by findings of the other reports. In some cases, however, even though a problem area was not considered a major problem in any given report, the occurrence of that problem in a majority of the reports amplifies its significance in SPIFR operations.

The analysis of the data included summaries of the purpose/objective, methodology, results, and recommendations/research of each report. This information was compiled and is presented in appendices 1-4. The integration and comparisons of these data were used to determine the key issues/problems and are presented in appendix 5. A summary of key issues/problems, appendix 5, and recommended research are presented in the analysis and discussion section.

## APPENDIX 1

### A. Purpose/Objective Summary

All of the reports related to the general Aviation pilot operating under instrument flight rules. Each study was read to determine the purpose and/or objective of the study. Statements have been extracted for ease in comparison. (Emphasis and underlining provided by the writer of this report.)

R1- Study to Determine the Operational Profile and Mission of the Certificated Instrument Rated Private and Commercial Pilot,

"The purpose of the proposed study is to determine the operational profile and mission of the certificated instrument rated private and commercial pilot. This study is the first phase of a Federal Aviation Administration effort which has as its objective the feasibility of training pilots to a standard of operational competence as a criterion for instrument rating certification." (p.1)

"The objectives of the study are:

1. Conduct a survey, statistically reliable, of the instrument rated private and commercial pilot.
2. Use a mail questionnaire approach of such scope as to produce information for which there can be developed an operational flight profile and mission of the instrument rated pilot.
3. From the information gained in the survey, develop two operational flight profiles depicting:
  - (a) the most difficult and complex operation.
  - (b) the medium operation.
4. Analyze the two profiles to determine those aeronautical skills and knowledge required to conduct safely such missions and profiles in today's air traffic control environment." (p.2)

R2- Single Pilot IFR Operating Problems Determined from Accident Data Analysis

"A general consensus is that one of the problems related to pilot error is the high single pilot workload on an instrument flight. To determine if this consensus is true, to define other problems areas, and identify areas of research in single pilot IFR (SPIFR) operations, it was decided that the general aviation accident report files of the National Transportation Safety Board (NTSB) should be examined and analyzed." (p. 2)

"An examination and analysis of the single pilot instrument flight rule (SPIFR) accident data for the years 1964-1975, compiled by the National Transportation Safety Board, was made for the purpose of identifying critical problem areas in SPIFR operations. The accident reports examined were restricted to instrument rated pilots flying IFR weather. A brief examination was made of accidents which occurred during all phases of flight and which were due to all causes. A detailed examination was made of those accidents which involved a single pilot, which occurred during the landing phase of flight, and were due to pilot error. The landing phase was selected because of the large number of accidents that occurred in this phase." (p. 18)

R3- General Aviation IFR Operational Problems

"This report presents the results of a study of general aviation IFR operators, particularly single pilot operators. The study was concerned with the operational problems these operators face, both now and in the next ten to twenty years." (p. 1-1)

"The intent of this study is to address the problems of single-pilot operators in the National Air Space System." (p. 2-1)

R4- Analysis of General Aviation Single Pilot IFR Incident Data Obtained from the NASA Aviation Safety Reporting System

Aviation Safety Reporting System (ASRS) data base is a compilation of voluntary incident reports from any persons who has observed or been involved in an occurrence which was believed to have posed a threat to flight safety.... This paper examines ASRS data for incidents related to general aviation SPIFR operations. In particular, all reports of general aviation fixed-wing aircraft flying under IFR in instrument meteorological conditions (IMC) are analyzed." (p. 1)

"The data in this report were obtained from the ASRS incident data base and were used to define problems and, hence, significant areas for research in the general aviation SPIFR environment." (p. 8)

R5- Operational Problems Experienced by Single Pilots in Instrument Meteorological Conditions

"The Objective of this study was to identify and analytically describe the operational problems reported to the ASRS by the general aviation airman operating as a single pilot in instrument meteorological conditions. A further interest was to understand the nature and type of operational problems being experienced by this class of airman, referred to as single pilot IFR, or SPIFR." (p. 2)

R6- Study to Determine the Operational Profile of the General Aviation Single Pilot

"The objective of the survey was to create a data base from which could be developed an operational profile of the general aviation single pilot operating under instrument flight rules (GA SPIFR)." (p.1)

"The purpose of this statistical summary report is to present the questionnaire data in a convenient form so that it can be reviewed and analyzed with the objective of identifying research which could lead to the elimination or reduction of the severity of specific problems experienced by the GA SPIFR." (p. 1)

R7- Single Pilot IFR Proficiency Analysis

"...GA SPIFR activity has continued to increase both in terms of number of flights and number of accidents, and the accident data from four additional years (1976-1979) have been added to the NTSB data base. The purpose of the research and analysis upon which this report is based was to determine what changes, if any, have occurred in trends and cause-effect relationships reported in the earlier study. The increasing numbers have been tied to measures of activity to produce accident rates which in turn were analyzed in terms of change." (p. 1)

The commonality of these reports is:

- . Two reports have concerns to develop an operation profile (R1, R6)
- . One report describes the aeronautical skill and knowledge required to operate in the system (R1)
- . Six reports identify the problems or problems areas of SPIFR (R2, R3, R4, R5, R6, R7)
- . Four reports lead to identifying areas of research (R2, R3, R6, R7)



## APPENDIX 2

### B. Methodology Summary

A description of the methodology used in developing the information in each report is presented in this section. When applicable, the population of reports used by the researcher(s) is included.

#### R1- Study to Determine the Operational Profile and Mission of the Certificated Instrument Rated Private and Commercial Pilot

In 1970 a mail questionnaire survey to 3046 of the 100,498 instrument rated Private and Commercial rated pilots was made. 1767 usable responses were received. 739 of those were determined to be engaged in general aviation flying. 262 were considered as complex operations (flies IFR flight plan every other week, made an actual instrument approach during last 12 months, had to hold at least once during last 12 months and have at least 1-360 and 1-90 channel COM radio). The other 477 were considered medium operations.

#### R2- Single Pilot IFR Operating Problems Determined from Accident Data Analysis

The NTSB Accident files for the years 1964 through 1975 were searched for accidents concerning general aviation, fixed wing aircraft, instrument rated pilots, who were in an actual IFR weather. This yielded over 1000 reports. Since a high percentage of these accidents were in the landing phase the report concentrates on the landing phase accidents that also included pilot error and where IFR flight plans had been filed. This yielded 335 accidents. These reports were examined for specific pilot errors which were tabulated against other accident cause/factors; different variables of flight were cross referenced and examined quantitatively; and the pilot's experience was examined. After analyzing the data, problems areas were identified and suggested areas of research were recommended.

#### R3- General Aviation IFR Operational Problems

Background information for the study was developed using primarily FAA reports and statistical information. This provided the foundation which described the general aviation IFR operators, the IFR operating environment, the IFR cockpit environment limitations of present avionics and planned improvements to the ATC system. Using an event analysis, and using additional FAA studies, NTSB accident briefs, NASA reports and NAFEC reports, 21 GA IFR operational problem areas were identified. Twelve broad solution areas and 16 research areas were identified.

R4- Analysis of General Aviation Single Pilot IFR Incident Data Obtained from the NASA Aviation Safety Reporting System

A search of the ASRS data base containing 2174 incident reports collected from May 1, 1978 to January 1, 1979 was made for all reports of general aviation, fixed-wing aircraft under IFR in IMC. 79 reports met the criteria and were reviewed (29 reports of flight crew error and 50 reports of ATC errors). The report 'enabling factors' and 'associated factors' were analyzed, listed, and then categorized into one of five major problem areas. The relative significance of each problem area was determined by the number of relevant enabling factors and associated factors cited in each of the problem areas.

R5- Operational Problems Experienced by Single Pilots in Instrument Meteorological Conditions

A search of the reports in ASRS Database 2 for reports from May 1, 1978 through December 10, 1980 for small aircraft (13,961 reports total) and through March 18, 1981 for small transport aircraft (15,246 reports total) was made for SPIFR operational problems (the safe and/or efficient conduct of a flight was adversely affected.) Multiple pilot crews, reports and conflicts occurring in see-and-avoid environment were eliminated. Only trips on IFR flight plans that encountered IMC remained for analysis (136 reports). The narrative of each report was analyzed and the report was classified into one of 10 operational problem categories identified by the researcher. The frequency of occurrence was totaled. Further analysis of the reports provides insight into safety, efficiency and workload concerns.

R6- Study to Determine the Operational Profile of the General Aviation Single Pilot

In 1981 a mail questionnaire survey was sent to 4943 of the 230,000 instrument rated and ATP pilots regarding SPIFR operations. 2211 usable questionnaires were received. Each question in the survey was reviewed and the frequency of like responses were recorded. A composite SPIFR operational profile, which consists of 38 characteristics was developed. In addition 10 questions about the nature of the GA SPIFR were posed by the researcher, and answers were developed using data from one or more questions in the survey. Also an advisory group reviewed the statistical summary to identify problem areas of concern to the GA SPIFR.

R7- Single Pilot IFR Proficiency Analysis

A review and examination was made of NTSB SPIFR accident reports for 1976-1979 in many of the same terms and formats used in the study of NTSB accidents from 1964-1975. Statistical methods were used to determine rate changes that

may have taken place. A comparison was made between the SPIFR pilot profiles developed from "The Study to Determine the IFR Operational Profile of the General Aviation Single Pilot" and NTSB accident statistical database. In addition, specific variables were related to specific types of accidents to particular conditions. Day and night accident rates are explored as well as an analysis of collisions with the ground.

#### In Summary

- . Two reports (R1, R6) use questionnaires to solicit first hand responses from pilots on their operations
- . Two reports (R2, R7) use NTSB accident reports to define problem areas
- . Two reports (R4, R5) use ASRS incident reports to gain insights into problems
- . One report (R3) uses an event analysis and statistics to forecast problems of the GA SPIFR in the ATC system



### APPENDIX 3

#### C. Results Summary

This section extracts the principle results from each of the reports. In order to keep the integrity of the reports, the results are direct quotes.

R1- Study to Determine the Operational Profile and Mission of the Certificated Instrument Rated Private and Commercial Pilot  
Based on inspection of the general aviation IFR data (739 reports) a "typical" general aviation instrument rated pilot and his flight operation is described. Numbered items correspond to the number of the question in the questionnaire. (pp. 3-7)

1. He flies a complex (having retractable gear and controllable propeller) single or multiengine aircraft, produced since 1965, having a cruise speed of 150-159 knots, and an approach speed of 100-109 knots.
2. His aircraft has two 360 channel transceivers, two VOR/LOC receivers, at least one glide slope receiver, ADF and marker beacon receivers, and a transponder. It is equipped with pitot heat and an autopilot with at least a roll capability.
3. His aircraft is most likely to be company owned.
4. He had much to say about the selection of the aircraft.
5. He received his private and commercial pilot certificates during the 1960's and his instrument rating since 1965.
6. He received his instrument rating on the basis of completing required FAA tests and experience. He is not a graduate of an approved flying school.
7. He is single and multiengine rated.
8. He has at least 2000 hours total time, with at least 250 hours in the last twelve months.
9. He flies about once per week, on an IFR flight plan about every other week.
10. He is current on instruments, having logged at least 25 hours instrument in the last twelve months. He has at least 140 hours total instrument time logged, at least 60 of which are actual instrument in an airplane.

R1- Continued

11. He has been a pilot in command in actual instrument weather conditions in the last six months.
12. His last instrument dual instruction or instrument flying evaluation ride was last year (1969).
13. During training for an instrument rating, he visited an air traffic control tower and an approach/departure control facility.
14. He considers 10 hours of actual instrument time worthwhile during training for the instrument rating.
15. Data in Question 15 reflects the distribution of responses by state.
16. He originates his IFR flights from an airport which has an ILS or a VOR approach.
17. He has most often made ILS approaches in the last twelve months.
18. During the last twelve months, he has most frequently flown for business (not for hire) or personal reasons.
19. He subscribes to USC & GS flight information publications, which are usually current.
20. He has had no need to cancel an IFR flight during the last 12 months. If he has, it was because of weather beyond his aircraft/equipment capability.
21. He tends to use the published minimums on instrument approaches as his personal minimums.
22. He will probably go on an IFR flight if light icing or scattered thunderstorms are reported anywhere enroute. He probably will not go if heavy ground fog is reported.
23. He will usually file IFR if his destination weather is forecast to be ceiling 5000 feet or less, visibility 5 miles or less.
24. He seldom or never cancels an IFR flight plan upon reaching VFR conditions after departing an airport in IFR weather.
25. He seldom or never files an IFR flight plan before departing on a flight to be conducted entirely in the daytime in good VFR conditions.

R1- Continued

26. He seldom or never files an IFR flight plan in flight.
27. 20 - 24% of his time on instrument flight plans is in actual instrument conditions.
28. He has made an ILS approach in actual instrument conditions during the last twelve months.
29. He operates IFR most often within a radius of 400 nm of his home airport.
30. The one way distance of his longest non-stop IFR flight during the last 12 months was 500 nm or less.
31. During the last 12 months, he has been rerouted or had to hold no more than twice and has not had to execute a missed approach or divert to an alternate.
32. He rates ILS, LOC and VOR approaches as having little difficulty, ADF approaches as having some difficulty.
33. He almost never receives assistance from someone during an IFR flight. When he does receive assistance, it is from another instrument rated pilot who is not a required copilot.
34. He has flown in a single engine aircraft in IFR, night VFR, and night actual IFR conditions.
35. He considers the six hours of instrument experience within the preceding 6 calendar months adequate in maintaining a safe level of instrument proficiency.
36. He considers himself at or just below the level of a professional pilot in aeronautical skill, knowledge, and experience.
37. He experiences little or some difficulty, but not much or extreme, in conducting IFR flights during departure, transition and approach phases.
38. He believes heading control to be the aspect of flying performance to deteriorate first as a "normal" IFR flight becomes more difficult because of IFR conditions.
39. He believes the reasons for his flying performance deterioration mentioned in the previous question to be caused by lack of recent instrument flying experience.
40. He believes the most common errors made by instrument

R1- Continued

pilots are:

- (1) not knowing personal limitations.
- (2) not planning ahead.
- (3) allowing skills to deteriorate.

41. He would like to see a requirement for actual instrument experience made a part of the training and regulations concerning the certification of new instrument pilots.
42. He mentions structural icing or thunderstorms as his most uncomfortable or threatening experience during an IFR flight in actual IFR conditions.

The complex instrument pilot profile was compared to the medium instrument pilot.

1. The complex pilot flies a more sophisticated aircraft. It has higher cruise and instrument approach speed, communications and navigation equipment with greater capability, and more special equipment. (Q. 1 and 2)
2. The complex pilot operates at busier airports. (Q. 17)
3. He is more likely to make approaches to minimums than the medium pilot. (Q. 21)
4. The complex pilot will make a "go" decision more often than the medium pilot in more adverse weather situations. (Q. 22)
5. In good VFR conditions, the complex pilot will more frequently file an IFR flight plan. (Q. 23 and 25)
6. He more often finds it necessary to file an IFR flight plan in flight. (Q. 26)
7. He is more likely to have made an actual instrument approach to lower minimums than the medium pilot. (Q. 28)
8. The complex pilot is more likely to have had to execute a missed approach or had to divert to an alternate. (Q. 31)
9. He has less difficulty in making instrument approaches. (Q. 32) (Page 29)

R1- Continued

The intent of the skill and knowledge requirements to safely operate in the ATC system of 1970 is to indicate generalized modifications to the present process of certificating the instrument rated pilot in a manner which will make it more consistent with how he actually operates in today's air traffic control system. (P. 31)

A. Task Activity: CONTROL OF AIRCRAFT (P. 37)

1. Both the complex and the medium pilot must have demonstrated their ability to make an ILS and a VOR approach to the published minimums.
2. Both pilots must have logged some actual instrument time during their training for an instrument rating.
3. The medium pilot shall not be permitted to make approaches as low as the complex pilot.
4. The complex pilot shall be required to demonstrate more precise aircraft control, especially heading and altitude, and particularly in the approach phase. Determination shall be made objectively by reference to quantitative standards of performance.

B. Task Activity: COMMUNICATION WITH ATC

1. Both pilots must have visited an approach/departure control facility during their training for an instrument rating.
2. The medium pilot must make communications which are correct in content, with acknowledgement and proper control response accomplished within a reasonable amount of time. Execution of ATC instructions must be accomplished in a manner which will not endanger himself or adversely interfere with the functions of the air traffic control system.
3. The complex pilot must communicate concisely, accurately, and promptly. Required control responses should be immediate. Forgetting air traffic control instructions or incorrect control responses shall be disqualifying.

R1- Continued

C. Task Activity: USE OF PRINTED INFORMATION (P. 38)

1. The medium pilot must be sufficiently familiar with flight information publications to find needed information in a reasonable amount of time and without excessive performance deterioration under normal IFR conditions.
2. The complex pilot must be able to refer to flight information publications and promptly ascertain information required without a deterioration in performance under non-normal IFR conditions.

D. Task Activity: DECISION MAKING (P. 38)

1. Both the medium and complex pilot shall demonstrate his understanding of hazardous weather and emergency situations by means of an oral and/or written analysis of a typical hazardous weather situation.
2. The medium pilot must demonstrate his knowledge of the characteristics and hazards associated with icing and thunderstorm conditions. He must know how to avoid such contingencies.
3. The medium pilot must demonstrate an ability to anticipate future tasks to the extent that essential preparations are performed prior to the time it causes his proper relationship to the system to be lost.
4. The complex pilot, in addition to demonstrating his knowledge of the characteristics and hazards associated with icing and thunderstorm conditions, must demonstrate his ability in operating aircraft anti and deicing equipment, and knowledge of the flying techniques associated with icing and thunderstorms.
5. The complex pilot must demonstrate a higher order ability to anticipate future tasks and manage his flight.
6. The complex pilot shall demonstrate his ability to make a missed approach to a holding pattern.

R2- Single Pilot IFR Operating Problems Determined from Accident Data Analysis

A detailed examination of accidents involving a single pilot, which occurred during the landing phase of flight, and which was due to pilot error resulted in the following information.

(p. 18-19)

- . Single-pilot pilot error accidents are increasing at a rate of 3.5 accidents per year. This rate is three times the dual-pilot pilot error rate. There were 877 single-pilot pilot error accidents, 446 of which occurred during the landing phase. Of the 446, there were 335 on IFR flight plan.
- . Improper IFR operations were given as a cause/factor in 170 of the 335 SPIFR accidents. In 104 of the improper IFR operations accidents fog was also a cause/factor and in 68 low ceiling was a cause/factor. Icing was a cause/factor in 56 accidents and fuel exhaustion was a cause/factor in 14.
- . There were 152 SPIFR accidents where the aircraft collided wings level with trees or with the ground. In 63 percent of these the visibility was one mile or less and in 70 percent it was dark.
- . Of the 335 SPIFR accidents there were 96 which occurred while the pilot was executing an ILS approach and 90 while executing a VOR approach. In general, the approaches which allowed lower descents had a higher percentage of accidents at night.
- . There were 139 SPIFR accidents which occurred during final approach. In these cases, the number of accidents doubled for every mile decrease in visibility. The initial approach phase had the highest fatality rate with .63 fatal accidents per accident. There were no fatalities in the leveloff/touchdown or rollout accidents.
- . There were 240 SPIFR accidents which occurred in fog, 180 in the dark, and 62 in below minimums weather. Air taxi-passenger and ferry operations had the highest below minimums accident rates.
- . Commercial pilots were involved in 56 percent of the 335 accidents, however, the number of accidents per 100,000 private pilots was three times that of commercial pilots. Forty-six of the accidents involved professional pilots.

R2- Continued

- . The pilots in the 335 accidents had an average of 3000 hours total pilot time. The pilots with less than 300 hours total time had the highest estimated accident rate and pilots with more than 7000 hours had the lowest. The accident rate for pilots with less than 100 hours of actual instrument time was one-half that of pilots with more instrument time. The accident rate was lowest for pilots with less than 25 hours in 90 days and highest for pilots with more than 200 hours.
- . Fifty-eight percent of the SPIFR accidents occurred in twin engine aircraft whereas an estimated 45 percent of the IFR operations were conducted in twins.

After analyzing the accident data, the following problem areas were identified.

- . Landing phase operations, especially on the final approach segment
- . Low visibility operations at night due to fog and low ceilings
- . Flight in icing conditions when the aircraft is not deicing or anti-icing equipped
- . Imprecise IFR navigation
- . Below minimums approaches
- . Weather data dissemination techniques and pilot understanding
- . Fuel mismanagement and inadequate fuel quantity information
- . Pilot overconfidence due to high instrument time and time in last 90 days
- . Low pilot time in aircraft type
- . High workload, especially in twin engine aircraft

R3- General Aviation IFR Operational Problems

A summary of the major SPIFR operational problems determined by the study is in the following list: (pp. 4-52 and 4-53) and (pp. 6-1 thru 6-3)

A. PILOT FACTORS:

IFR Training Inadequacies

High Workload in Critical Flight Phases

High Workload in High Density Environments

Future Traffic Growth Rate in High Density Areas

Potential Workload Impacts of New ATC Features

Growing Vehicle Control Complexity

B. MISSION RELIABILITY AND EFFICIENCY:

Flight Planning/Information Availability

Flight Delays in Dense Terminal Areas

Lengthy Delays/Diversions in IMC

Limited Availability of Landing Aids

Routing Inefficiencies

Enroute Weather Avoidance Delays

Low Density Area Delays Due to Lack of Tower

C. SAFETY:

Maintaining Required Separation

Weather-Related Accidents

Growing Airborne Alert Environment Complexity

Final Approach Accidents

D. COMMUNICATIONS:

Communications Channel Congestion

Communications Errors, Omissions and Dropouts

Lack of Tower or Off-Hours Services

Access to Evolving Ground Data Base

The general conclusions stated in this section are presented in an effort to emphasize the magnitude and pervasiveness of the GA IFR operator's problems.

- A. At present GA IFR operations constitute a major segment of the U.S. air transportation system. Projections show that in the future, GA IFR operations will grow to the point where they will dominate air carrier operations in terms of sheer numbers. This is true in high density urban areas as well as outlying areas. The major finding of this study is that the GA IFR operator's problems are very serious, and will get much worse.
- B. The primary role of the FAA is to be the provider of ATC services. Thus it is in character that the thrust of the FAA's own modernization program is to improve the efficiency with which such services are provided, without necessarily concentrating on the efficiency of the services themselves or the particular needs of the various classes of operators. The resulting ATC facilities modernization plans for the most part will result in continued, or increased, operating costs for GA IFR operators while not significantly improving the efficiency of their operations. Potential exceptions include the program for improved weather data collection and distribution, the ATARS concept, factors improving airport capacities, and area navigation (which will be implemented very slowly).
- C. ATC plans for expansions to positive controlled airspace through reductions in the altitude "floor" and through expansions to the number of TCA's tends to drive general aviation out of that airspace, and in particular, drives lower capability IFR operators away while, possibly, attracting the higher capability IFR operators (45). Unfortunately for the lower capability GA IFR operators he is therefore being driven away from the very services he needs so desperately.

R3- Continued

- D. In light of the above factors, the cost to a GA IFR operator to improve his mission reliability on his own is very high and the payoff which results is often insufficient to cover that cost. Likewise, the cost to an airport operator to provide the ground segments of these ATC services is very high utilizing present technology, and so is typically justified only at airports with significant air carrier traffic, or very large GA airports.
- E. The tendency of the ATC system to control more and more airspace as time passes provides improved safety to controlled aircraft but at a general price of reduced operating efficiency for those aircraft. Also such trends tend to drive many operators out of that airspace, actually degrading their safety of operation by compressing them in a smaller amount of airspace. A potential solution to this problem is to improve the means by which aircraft operators can manage their own separation and ATC procedures, either through air-derived collision avoidance sensors, or through the display of ground-derived traffic data.
- F. A comprehensive, well planned attack on the operational problems of GA IFR operators is needed to provide viable and economical solutions in order that such a valuable transportation resource can develop to the benefit of all. This program will include research which not only addresses the technology development issues, but the operational procedures issues as well.

R4- Analysis of General Aviation Single Pilot IFR Incident Data  
Obtained from the NASA Aviation Safety Reporting System

The incident reports were used to define problems and several elements for each problem were determined. (p. 13)

- A. Controller judgment and response problems
  - Excessive/impeding procedural requirements
  - Training/proficiency/experience related mistakes
  - Equipment operational problems
- B. Pilot judgment and response problems
  - Excessive/impeding procedural requirements
  - Training/proficiency flight infractions
  - Limitations due to limited avionics

R4- Continued

- C. ATC intrafacility and interfacility conflicts
  - Internal communication problems
  - Hand-off problems
  - Mixed departure and arrival conflicts
  - Equipment operational problems
- D. ATC and pilot communication problems
  - Misunderstanding of instructions
  - Frequency congestion
  - Excessive frequency changes
  - Excessive/impeding procedural requirements
- E. IFR-VFR conflicts
  - Aircraft proximity at breakout
  - IFR flight in VFR and MVFR conditions

A review of the problem areas also pinpointed several points common to all or most of the problems. These included human error, communications, procedures and rules, and workload.

R5- Operational Problems Experienced by Single Pilots in Instrument Meteorological Conditions

Analysis of the 136 reports in the ASRS database produced 9 conclusions. (pp. 35-36)

- A. Ten SPIFR Operational Problem Categories have been identified in the ASRS-2 database. In order of decreasing frequency of occurrence, they are: Pilot Allegations of Inadequate Service (30 percent), Altitude Deviation (20 percent), Improperly Flown Approach (15 percent), Heading Deviation (13 percent), Position Deviation (7 percent), Below Minimums Operations (6 percent), Loss of Airplane Control (3 percent), Forgot Mandatory Report (3 percent), Fuel Problem (2 percent), and Improper Holding (2 percent).
- B. It appears that the operational problems being experienced by the SPIFR may be independent of experience. Although this hypothesis needs to be tested more thoroughly, it is suggested that if the hypothesis were found to be valid then remedies to SPIFR operational problems do not lie in improving SPIFR capabilities through more training and experience. Rather, the nature of the SPIFR task should be changed through the redesign of cockpit systems and ATC procedures in handling the SPIFR.

R5- Continued

- C. Safety, Efficiency, and Workload factors are present in SPIFR Operational Problem occurrences. Half of the occurrences involved an act or condition likely to lead to grave consequences, and one-third involved an act or condition of ignorant or imprudent deviation from acceptable procedures. In more than one-third of the occurrences, the efficiency of IFR flight was depending upon what determinant is used to assess workload, between one-quarter and three-quarters of the occurrences involved workload as causal factor.
- D. The most frequently identified SPIFR Operational Problem was a pilot's allegation of inadequate service. Three-quarters of such allegations are deemed reasonable.
- E. A pilot's "mind set" was a factor in altitude deviations, appearing in 68 percent of the occurrences.
- F. Lack of pilot proficiency is apparent in improperly flown approach occurrences. In 22 percent of these occurrences, there was evidence that pilots did not understand when not to execute a procedure turn.
- G. The pilot's lack of awareness of his position is an important factor in position deviation occurrences.
- H. Takeoff below minimums occurrences were related to the pilot's cognitive processes. Landing below minimums occurrences probably could have been prevented by better preflight weather planning and more conservative decision making by the pilot.
- I. Loss of airplane control generally followed the pilot being distracted. Even relatively experienced pilots lost airplane control.

R6- Study to Determine the Operational Profile of the General Aviation Single Pilot

A composite description of the GA SPIFR and his operational profile was developed from an inspection of the data in the statistical summary. Each item is referenced to the number of the question in the questionnaire. (i.e. Q.1) (pp. 4-7)

- Q.1. He flies a single engine airplane (four places and over), having retractable gear and controllable propeller, produced since 1974, having a cruise speed of 140-149 knots, and an instrument approach speed of 100-109 knots.

R6- Continued

- Q.2. His airplane is equipped with two communications transceivers, two VOR/LOC receivers, one glide slope receiver, an ADF and a marker beacon receiver, transponder with altitude encoder, and a DME receiver. It has an autopilot with roll and heading capability. It is also equipped with pitot heat and a headset boom microphone.
- Q.3. In his opinion, inaccurately assessing and exceeding one's personal limitations and capabilities is the most common error made by IFR single pilots.
- Q.4. The one most serious problem which he has encountered in his experience as an IFR single pilot has been icing.
- Q.5. He handled the problem by obtaining an ATC clearance to a different altitude/heading.
- Q.6. Unforecast and unanticipated weather was the most frequent unanticipated thing which happened during his last three flights as an IFR single pilot.
- Q.7. Better, more up to date weather information/briefings is the one change in the system which would make his IFR single pilot flight operations easier.
- Q.8. Given a single engine airplane with one NAV/COM/LOC, and \$7,500, he would purchase the following additional equipment: transponder, 360 or 720 channel transceiver, glideslope receiver, marker beacon receiver, second VOR/LOC receiver, pitot heat, ADF receiver and an altitude encoder.
- Q.9. He believes that instrument approach procedures should be included in his biennial flight review.
- Q.10. He has experienced no difficulties with instrument flight instruction, procedures and techniques.
- Q.11. In obtaining preflight aviation weather information, he almost always makes a direct call to FSS; often uses TV weather; seldom visits FSS, seldom uses PATWAS or TWEB; and never uses "AM Weather" or the newspaper.
- Q.12. In obtaining inflight aviation weather, he almost always uses ATIS; often uses direct FSS communication or EFAS; seldom uses ARTCC or TWEB.

R6- Continued

- Q.13. He believes that ATC demands are a problem during instrument approaches, and that better controller awareness about the nature of the GA SPIFR operation would solve this problem.
- Q.14. He believes that inadequate lighting is a cockpit environment problem, and that better lighting would solve this problem.
- Q.15. He believes that there are no navigation type problems.
- Q.16. He believes that the Federal Aviation Regulations and ATC procedures are too complex and excessive, and that they should be simplified.
- Q.17. He believes that maintaining recency of experience is a problem, and that the use of more simulators would solve this problem.
- Q.18. He believes that poor stability is a problem in airplane stability and control and that the use of an autopilot would solve this problem.
- Q.19. He believes that the reliability of FSS weather information is a problem, but cannot recommend a solution to the problem.
- Q.20. He believes icing to be a weather problem and that radar more sensitive to weather phenomena should be developed.
- Q.21. He believes that too many communications frequency changes are a problem, and that the system should be designed so as to require fewer frequency changes.
- Q.22. As a "normal" IFR flight becomes more difficult because of workload, ATC communications and clearance interpretation is the aspect of his flying performance which is most likely to deteriorate. He attributes this deterioration to getting too busy with other tasks, having his attention divided, and not having enough time.
- Q.23. During an instrument approach in actual IFR conditions, he often encounters the "normal" IFR condition and has little difficulty with it. He seldom encounters minimum ceiling and/or visibility, light or moderate icing, light or moderate turbulence, or nonroutine ATC instructions; when he does, he experiences little

R6- Continued

difficulty in handling the situation. He seldom encounters scattered or broken thunderstorms, or strong winds; when he does, he has some difficulty in handling the situation.

- Q.24. He flies from one of the higher aviation activity states, having a high percentage of the nation's more than 13,000 airports and 210,000 general aviation aircraft.
- Q.25. During the last twelve months, the most frequent approach he has flown was an ILS approach with radar assistance available.
- Q.26. He seldom has someone assist him in the airplane during a flight in actual IFR conditions. If he does, the person is a pilot but does not have an instrument rating, and is not a required copilot.
- Q.27. He would often prefer to have someone assist him in the airplane during flight in actual IFR conditions.
- Q.28. During the last twelve months, when he has had to cancel an IFR single pilot flight just before planned departure it was because of weather beyond his personal limitations.
- Q.29. During the daytime, he would go when light icing, light or moderate turbulence, heavy rain, scattered or broken thunderstorms, IFR over mountains, or IFR over water were reported to exist anywhere enroute. He would not go during the day if moderate icing, lines of thunderstorms, heavy ground fog or weather below minimums were reported. At night, he would go when light or moderate turbulence, scattered thunderstorms, or IFR over water were reported to exist anywhere enroute. He would not go at night if any of the other previously mentioned conditions were reported.
- Q.30. He uses the published minimums on instrument approach procedures as his personal minimums.
- Q.31. If the weather were reported to be below minimums at his destination airport, he would not fly the approach.
- Q.32. During the last twelve months, he has (a) filed IFR ten times, (b) had to hold once, (c) not had to execute a missed approach, (d) been rerouted twice, (e) not had to divert to an alternate, (f) not had to ask for an

R6- Continued

altitude change due to icing, (g) asked for a route change due to thunderstorms once, (h) not had to declare an emergency, (i) not requested special handling.

- Q.33. He received his private pilot certificate in 1970, his instrument rating in 1973, his commercial certificate in 1974, and his multi-engine rating in 1976. He is not ATP and is not an instrument flight instructor.
- Q.34. During the last twelve months, all flying and single pilot IFR flying was for personal (pleasure) or business (not for hire) purposes.
- Q.35. During the last twelve months, he flew VFR and on an IFR flight plan more than four times per month, but in actual IFR conditions less than once per month.
- Q.36. On a scale of one (low) to six (high), he scores his skill and experience at four, his knowledge at five.
- Q.37. In the last twelve months, he has logged 210 hours total time, 190 as pilot in command, less than 20 single pilot actual instrument and less than 20 simulated instrument in an airplane and in a ground trainer. He has 2050 hours total time, 1750 pilot in command, less than 100 single pilot actual instrument, and less than 100 simulated instrument in an airplane and ground trainer.
- Q.38. He is a 40 year old male.

The GA SPIFR data set has considerable potential for answering questions about the nature of the GA SPIFR flight operation in terms of his airplane and equipment characteristics. In order to use this potential properly, however, first an appropriate and relevant question must be formulated. Then, the right combination of data must be analyzed with the correct statistical analysis techniques in order to develop a reasonable answer.

As an illustration that the survey data can be used to answer questions about the nature of the GA SPIFR, relatively simple questions are presented in the pages which follow, and the answer is developed using data from the GA SPIFR survey.

QUERY 3: How many respondents have not encountered a problem in a particular area?

R6- Continued

CONCLUSION: A high percentage of SPIFR's are not experiencing any problems with the various activities, systems, and environments to which they are exposed during the conduct of a SPIFR flight.

QUERY 4: What is the relationship between the different types of airplanes being flown SPIFR and the single pilot actual instrument flight time flown in the last 12 months?

CONCLUSION: More total SPIFR hours are being flown in airplanes appearing with greater frequency. The more complex the airplane, the greater the average hours flown. The turbojet sample is too small for meaningful results.

QUERY 5: What is the relationship between the type of SPIFR flying and the type of airplane most often flown SPIFR?

CONCLUSION: The more sophisticated the airplane, the more likely it is to be used in a business or air transportation for hire function.

QUERY 6: What is the relationship between the type of SPIFR flying and the equipment aboard the airplane most often flown SPIFR?

CONCLUSION: Aircraft used for business or air transportation functions are likely to be better equipped.

QUERY 7: Are the operational problems experienced by the SPIFR independent of experience?

CONCLUSION: Based upon this analysis, which reveals the relatively high commonality of response codes reported between categories of pilots of different experience levels, it appears that the operational problems experienced by the SPIFR are independent of experience. If this hypothesis is valid, then it is suggested that remedies to SPIFR operational problems do not lie in improving SPIFR capabilities through more training and experience. Rather, the nature of the SPIFR task should be changed through the redesign of cockpit systems and ATC procedures in handling the SPIFR.

Categories of pilots for analysis:

- A - Less than 10 hours single pilot actual instrument in last 12 months (n= 726)
- B - 60 hours or more single pilot actual instrument in last 12 months (n=130)
- C - 30 hours or more single pilot actual instrument in last 12 months and has been a flight instructor/instrument (n=168)

R6- Continued

QUERY 10: Was there any information gleaned from the 231 respondents who returned unusable questionnaires?

CONCLUSION: An analysis of the 231 unusable returns revealed the following breakdown of responses:

<u>Response</u>	<u>Number</u>	<u>Percent</u>
I never fly SPIFR (it's unsafe)	83	36%
All my flying is military	53	23
All my flying is airline	40	17
I have not flown IFR for some time	16	07
Unusable response	14	06
I am retired and do not fly	13	06
All other	12	05
Total	231	100%

QUERY 11: What is the comparison between the certificates held by the respondents in the GA SPIFR data set to the total sample?

CONCLUSION: An analysis of the certificate composition of both the GA SPIFR data set and the total sample disclosed the following distribution:

<u>Certificate</u>	<u>GA SPIFR Data Set</u>		<u>Total Sample</u>	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
Private	368	23%	750	15%
Commercial	878	54	2889	58
ATP	373	23	1304	26
Total	1619		4943	

QUERY 12: Can the results of this survey be compared to any earlier surveys?

CONCLUSION: Yes, a similar survey was conducted by the Federal Aviation Administration in 1970. (3) Of particular interest are the following comparisons:

R6- Continued

Most common error made by instrument rated pilots;	
<u>1970 Survey (Q. 40)</u>	
Not knowing personal limitations	16%
Not planning ahead	16
Confidence in being able to handle weather	06
<u>1981 Survey (Q. 3)</u>	
Not planning ahead	16%
Overconfidence/ignorance in being able to handle weather/limitations/capabilities	11
Exceeding inaccurate assessment of personal limitations/capabilities	08
Most uncomfortable or threatening experience/ one most serious problem encountered:	
<u>1970 Survey (Q. 42)</u>	
Structural icing	29%
Thunderstorms	12
<u>1981 Survey (Q. 4)</u>	
Icing (structural or induction system)	16%
Thunderstorms	07

R7- Single Pilot IFR Proficiency Analysis

PREVIOUS TRENDS REEXAMINED

Summary on Trends. The overall conclusion of the authors after compiling and analyzing the data to update the charts from the previous report (reference A), is that SPIFR accident frequency, totals, causes, and trends have undergone little overall change since the previous study. Thus, the conclusions, conjecture, and recommendations of the original work remain as valid today as they did when written. With this in mind, conjecture on small nuances has been held to a minimum so that maximum effort could be devoted to more detailed analysis of factors associated with controlled and uncontrolled collisions with the ground/water. (P. 13)

R7- Continued

PILOT PROFILES

Summary: Based upon the results of this section, the indications are that the SPIFR pilot involved in one or more accidents (i.e. from the NTSB data) has comparable amounts of total flight hours and is as current in flight time over the previous 90 days as is the typical GA pilot. However, there appears to be statistically significant differences in the amount of instrument experience each of the two groups have. One logically would expect the differences between the groups to both be off in the same direction for simulated and actual instrument hours, but such is not the case. The actual instrument experience of the typical NTSB SPIFR pilot is greater than that of the general population GA pilot while the latter's simulated instrument experience is higher than the NTSB representative. (P. 17)



## APPENDIX 4

### Recommendations/Research Summary

In this section, the recommendations for investigation or research activities to address problems are extracted from each report. For each report, the recommendations (if any) are listed as they appear in the report. The differences in the form of the recommendations reflect the purpose of the study that was conducted by an investigator and the specificity that was expected of the product of the study.

R1- Study to Determine the Operational Profile and Mission of the Certificated Instrument Rated Private and Commercial Pilot

None specified

R2- Single Pilot IFR Operating Problems Determined from Accident Data Analysis

Research aimed at solving these problems must emphasize low cost, low volume, low weight equipment, and human factors considerations. The following are suggested areas of research.

- . Cockpit displays of aircraft position on area mapping
- . New types of deicing or anti-icing equipment
- . Low/medium frequency receivers which can give on-course information
- . Standardized and human factors designed navigation instrument displays
- . Improved fuel management systems
- . Better methods for pilots to safely acquire experience and increase proficiency
- . Better cockpit displays of weather information

- . Improved air-to-ground communications which would reduce pilot workload
- . Improved basic aircraft stability and control
- . Low-altitude warning systems
- . More effective pilot training methods

### R3- General Aviation IFR Operational Problem

Table 5-1 is matrix of the operational problems vs the candidate solutions. The letters in the chart (A thru P) represent research tasks that are found in table 5-2.

Table 5.1 Recommended Research Areas and Operational Problem/Solution Relationships

OPERATIONAL PROBLEMS	CANDIDATE SOLUTIONS												
	Configuration Control and Display Integration	Promote CAS/PWI Development	Develop Distributed Management	Develop Remote Weather Management/TSD Concepts	Assess Data Link Weather Display Concepts	Requirements of Automated Avionics Concepts	Area Coverage Precision Landing Aids	Advance HUD, VASI and Remote Towers	Enhance IFR Training Programs	Innovative Communications Procedures	Efficient Route Reorganization of RNAV		
<b>PILOT FACTORS</b> IFR Training Inadequacies High Workload in Critical Flight Phases High Workload in High Density Environments Future Growth Rate of High Density Areas Potential Workload Impacts of New ATC Features Growing Vehicle Control Complexity	A A A A A		E E E						N N N N N N		O		
<b>MISSION RELIABILITY AND EFFICIENCY</b> Flight Planning/Information Availability High Delays in Dense Terminal Areas - Limits to ATC Arrival Time Control - Controller Workload Limits to Capacity - Delays in Traversing Dense Areas Lengthy Delays/Diversions in IMC Limited Availability of Landing Aids Routing Inefficiencies Enroute Weather Avoidance Delays Low Density Area Delays Due to Lack of Tower			D F/G F/G	H	I		J J	L L				P	P
<b>SAFETY</b> Maintaining Required Separation Weather Related Accidents Airborne Alert Environment Complexity Final Approach Accidents	B	C	F/G	F/G	H				K/M	N N			
<b>COMMUNICATIONS</b> Communications Channel Congestion Communication Errors, Omissions and Dropouts Lack of Tower or Off-Hours Services Access to Evolving Ground Data Bases					H H H	I						O O	

R3- Continued

Table 5.2 Summary of Research Tools

RESEARCH TASK	RESEARCH TOOL			
	ANALYSIS	SIMULATION		FLIGHT TEST
		COCKPIT	ATC	
A) INTEGRATED CONFIGURATION CONTROL/ DISPLAYS COCKPIT INFORMATION REQUIREMENTS AND HUMAN FACTORS PERFORMANCE REQUIREMENTS AND TECHNOLOGY ALTERNATIVES	X X	X		
B) ALERT SYSTEM INSTRUMENTATION/DISPLAY FACTORS	X	X		
C) RESOLVING CONFLICTING DATA SOURCES	X			
D) TSD PILOT/CONTROLLER TASKS	X		X	
E) TSD INFORMATION REQUIREMENTS/PILOT WORKLOAD	X	X		
F) REMOTE WEATHER/TSD EVALUATION ENROUTE/TERMINAL CAPACITY IMPACT PILOT WORKLOAD IMPACT	X X	X	X	
G) WEATHER DISPLAY/TSD DATA LINK REQUIREMENTS	X	X	X	
H) COMM. DATA LINK IMPACT	X	X	X	
I) REMOTE TOWERED AIRPORT COMM. REQUIRE- MENTS	X	X		
J) LOW COST PRECISION APPROACH AIDS	X			X
K) EXTERNAL STIMULUS APPROACH MONITOR		X		X
L) AREA COVERAGE NON-PRECISION APPROACH REQUIREMENTS	X			X
M) HEAD-UP DISPLAYS  DESIGN AND TECHNOLOGY REQUIREMENTS PILOT PERFORMANCE/WORKLOAD	X	X		X
N) PILOT TRAINING REQUIREMENTS SYLLABUS/PROFICIENCY FOR HIGH DENSITY/ATC TRAINING REQUIREMENTS OF NEW PROCEDURES/AVIONICS	X	X X		
O) REDEFINITION OF COCKPIT/ATC PROCEDURES	X	X	X	
P) ROUTE STRUCTURE EFFICIENCY	X			

R4- Analysis of General Aviation Single Pilot IFR Incident Data  
Obtained from the NASA Aviation Safety Reporting System

The data in this report were obtained from the ASRS incident data base and were used to define problems and, hence, significant areas for research in the general aviation SPIFR environment. Five general problem areas were identified from the data: (1) Controller judgment and response problems, (2) Pilot judgment and response problems, (3) ATC intrafacility and interfacility conflicts, (4) ATC and pilot communication problems, and (5) IFR-VFR conflicts. Several elements were determined for each of these problem areas, and the compilation of these areas and elements can be used to define specific research programs. The relative severity and, hence, the significance of each problem area, is defined and can be used as a reference for determining appropriate SPIFR research efforts. (See tables below)

TABLE II. - RELATIONSHIP BETWEEN PROBLEM AREAS AND ENABLING FACTOR GROUP		
Problem Area	Factors Cited	
	Directly Related	Indirectly Related
Controller judgment and response problems	56	8
Pilot judgment and response problems	30	0
ATC intrafacility and interfacility conflicts	8	56
ATC and pilot communication problems	5	86
IFR-VFR conflicts	0	38

R4- Continued

TABLE III. - RELATIONSHIP BETWEEN PROBLEM AREAS AND ASSOCIATED FACTOR GROUP		
Problem Area	Factors Cited	
	Directly Related	Indirectly Related
Controller judgment and response problems	34	32
Pilot judgment and response problems	8	16
ATC intrafacility and interfacility conflicts	16	49
ATC and pilot communication problems	9	42
IFR-VFR conflicts	15	24

R5- Operational Problems Experienced by Single Pilots in  
Instrument Meteorological Conditions

None specified

R6- Study to Determine the Operational Profile of the General  
Aviation Single Pilot

Recommended research based upon the results of the GA SPIFR  
survey falls into three categories:

1. Broad areas of research indicated by the problems which  
the GA SPIFR reports he is experiencing.
2. Further, more detailed analysis of the GA SPIFR survey  
data.
3. Search for "unique" solutions to specific GA SPIFR  
problems.

#### Broad Areas of Research

The Problems Identification section provide information from  
which the following broad areas of potential GA SPIFR research  
were deduced.

## R6- Continued

### Workload

- Optimize wherever feasible

### Pilot Judgment and Decision Making

- Improve pilot's ability to plan ahead
- Improve pilot's ability to more accurately assess his own capabilities and limitations

### Instrument Approaches

- Revise ATC procedures to minimize pilot workload

### Weather Information

- Improve availability, reliability, timeliness (especially with respect to icing and thunderstorms)

### Cockpit Environment

- Better lighting
- Better noise protection

### Communications

- Minimize communications workload

## Further Detailed Analysis

Further detailed analysis of the survey data can provide additional insight into the nature of the GA SPIFR and his operational problems in the following ways:

1. Providing answers to specific questions about the GA SPIFR, as was illustrated in the section on Selected Data Analysis Examples.
2. Allowing a further test of the hypothesis that the operational problems experienced by the GA SPIFR are independent of experience.
3. Determining whether a change in design, training, regulation, or procedures, or a combination thereof, is the most appropriate solution to a particular problem or class of problems.

It is suggested that an analysis of the response codes to Questions 3 through 7, 9, 10, and 13 through 22 be performed to aggregate them into a fewer number. The aggregation scheme used should combine response codes having similar characteristics, thereby permitting more meaningful detailed analysis. Care should be exercised during the aggregation process so that useful detail is not lost.

R6- Continued

As a next step in further detailed analysis, it is suggested that cross tabulations (or matrices) be developed for the responses to Questions 3 through 7, 9, 10, 13 through 22, 28 and 29 and the following variables:

Pilot Certification (private, commercial, ATP) (Q. 33)  
 Type of Airplane (Q. 1)  
 Level of Avionics (minimum, medium, maximum) (Q. 2)  
 Autopilot vs. No Autopilot (Q. 2)  
 No Autopilot (copilot, no copilot) (Q. 2, Q. 26)  
 Recent experience with SPIFR (high, medium, low) (Q. 32, Q. 37)  
 Type of Flying (Q. 34)

Based upon the insights gained in the cross tabulations, a multi-level set of GA SPIFR operational profiles could then be developed and run against the same set of questions as the above variables. As an example, the following set of profiles could be researched in order to determine if there are problems peculiar to particular profile:

Variable	Operational Profile Level					
	1	2	3	4	5	6
Pilot certification	ATP	ATP	COM	COM	PVT	PVT
Airplane	TBP	MEP	MEP	SEP	MEP	SEP
Avionics	MAX	MED	MAX	MED	MED	MIN
Autopilot	YES	YES	YES	NO	YES	NO
Copilot	YES	NO	YES	NO	NO	NO
Recency of SPIFR	HI	MED	HI	MED	MED	LOW
Type of Flying	CORP	BUS	CORP	BUS	BUS	PER
	or		or			
	ATX		ATX			

An analysis of the confidence level in the responses to each question could probably be performed. This analysis would reveal questions which were often not answered, or were to sensitive or non-relevant to the respondent. As a variation of this analysis, certain respondents could be removed from the GA SPIFR data set (N = 1619) because they did not answer a sufficient number of questions, perhaps leaving a more meaningful data set for analysis.

Finally, Question 7 appears to have a high potential for assigning priorities to desirable changes in the GA SPIFR operation. Aggregated responses to this question, in particular, should be examined in relation to other findings developed as a result of a more detailed analysis of the GA SPIFR survey data.

## R6- Continued

### Search for "Unique" Solutions

There is an intuitive feeling among certain researchers that the GA SPIFR survey data should contain truly novel and effective suggestions provided by the respondents as solutions to certain GA SPIFR problems. An Analysis of the most frequently reported problem/solution codes for Questions 13 through 21 suggests that there are no revelations in the data, as far as the researcher experienced in this area is concerned. If there are unique solutions in the data, then they are well hidden and special analyses will be required to identify them.

On the other hand, perhaps the unique solutions are disguised in common aeronautical terms, and analyst judgment and insight in interpreting the data is all that is required to identify them. For example, improving the availability, reliability and timeliness of weather information has been identified as an area for further research. An examination of the most frequently mentioned problem codes for Questions 19 and 20, with the associated solution codes, reveals that a more well developed PIREP system might, in the GA SPIFR's view, reduce the severity of the weather information problem.

In any event, if a search for unique solutions is conducted, it should be done only for those problems which are deemed to be significant in the first place. Further, the solutions suggested are from the viewpoint of a pilot respondent, and the worth of a suggested solution must be tested against its feasibility.

## R7- Single Pilot IFR Proficiency Analysis

Throughout the report, many subjects are discussed which lend themselves to further analysis and speculation. The authors sincerely hope that the efforts represented on these pages provide seeds for future research which will help reduce the GA accident rate. Two general areas which are suggested for closer scrutinization are:

1. The impact of simulated instrument time upon the likelihood of a SPIFR accident. Specifically, one would very much like to know how much impact reporting procedures in the NTSB accident briefs effect the statistics discussed in this report relating to simulated instrument time. Why are the levels of simulated instrument time that appear for the SPIFR pilots in the NTSB data base and the Ohio State survey as diverse as they are?
2. The disparity between day and night SPIFR accident rates. Out of 5,416 SPIFR accidents from 1964 to 1975 which involved pilot error, only 14 percent occurred at

R7- Continued

night. Based upon our estimate of night time activity (12.8 percent of overall activity) derived from the "General Aviation Pilot and Aircraft Activity Survey", it appears that SPIFR accident rates are unaffected by the condition of light while SPIFR approach/landing phase accident rates are magnified by 10 fold.

## APPENDIX 5

### Integration and Comparison

This section disaggregates the finding and conclusion of the studies and reaggregates the findings into relevant subject areas. The findings are extracted and presented in this section in the form in which they appeared in the report. Each item is referenced to the report (R) the page number (p.) and paragraph or listing number (Para. - or No. -). This section permits the reader to readily compare the works from the seven reports as it pertains to the subject listed. It is also apparent, in some cases, that the statement by the authors is not a "stand alone" in that subject area but overlaps other subjects.

#### A. Ratings

He is single and multiengine rated. (R. 1, p. 4, No. 7)

He received his private pilot certificate in 1970, his instrument rating in 1973, his commercial certificate in 1974, and his multiengine rating in 1976. He is not an ATP and is not an instrument flight instructor. (R. 6, p. 7, No. 33)

Commercial pilots were involved in 56 percent of the 335 SPIFR accidents, however, the number of accidents per 100,000 private pilots was three times that of commercial pilots. Forty-six of the accidents involved professional pilots. (R. 2, p. 19)

Passenger (PAX), Freight (FRT) and Charter (CHR) operations are typically flown by professional pilots. Of the occurrences in which the Operation is identified, 9 percent of the SMA set and 50 percent of the SMT set are in these three categories consistent with the tendency for SMT aircraft to be flown by professional pilots. (R. 5, p. 6)

Summary: The composite general aviation SPIFR is single and multiengine rated; has had an instrument rating for about 8 years and a commercial pilot certificate for 7 years.

#### B. Training

He received his private and commercial pilot certificates during the 1960's and his instrument rating since 1965.  
(R. 1, p. 3, No. 5)

## B. Training Continued

He received his instrument rating on the basis of completing required FAA tests and experience. He is not a graduate of an approved flying school. (R. 1, p. 3, No. 6)

He has experienced no difficulties with instrument flight instruction, procedures and techniques. (R. 6, p. 5, No. 10)

During training for an instrument rating, he visited an air traffic control tower and an approach/departure control facility. (R. 1, p. 4, No. 13)

His last instrument dual instruction or instrument flying evaluation ride was last year (1969). (R. 1, p. 4, No. 12)

He believes that instrument approach procedures should be included in his biennial flight review. (R. 6, p. 5, No. 9)

He considers 10 hours of actual instrument time worthwhile during training for the instrument rating. (R. 1, p. 4, No. 14)

He would like to see a requirement for actual instrument experience made a part of the training and regulations concerning the certification of new instrument pilots. (R. 1, p. 7, No. 41)

IFR Training Inadequacies considerations include:

Pilot Workload (R. 3, p. 4-24, para. 4.2.4); and Approach and Landing Accidents (R. 3, p. 4-43, para 4.3.9)

It appears that the operational problems being experienced by the SPIFR may be independent of experience. Although this hypotheses needs to be tested more thoroughly, it is suggested that if the hypothesis were found to be valid then remedies to SPIFR operational problems do not lie in improving SPIFR capabilities through more training and experience. Rather, the nature of the SPIFR task should be changed through the redesign of cockpit systems and ATC procedures in handling the SPIFR. (R. 5, p. 35, No. 2)

Summary: The SPIFR pilot completed training with no particular difficulties; would like to see a requirement for actual instrument experience; and believes instrument approach procedures should be included in a BFR.

### C. Experience

He has at least 2000 hours total time, with at least 250 hours in the last twelve months. (R. 1, p. 4, No. 8)

In the past twelve months, he has logged 210 hours total time, 190 as pilot in command, less than 20 single pilot actual instrument and less than 20 simulated instrument in an airplane and in a ground trainer. He has 2050 hours total time, 1750 pilot in command, less than 100 single pilot actual instrument, and less than 100 simulated instrument in an airplane and ground trainer. (R. 6, p. 7, No. 37)

Over half the SMA pilots who reported their flight time have 2000 hours or more total time, and 50 hours or more in the last 90 days. Similarly, half of the SMT pilots have 4000 hours or more total time, and over half have 150 hours or more in the last 90 days. (R. 5, p. 7, para. 5)

The pilots in the 335 accidents had an average of 3000 hours total pilot time. The pilots with less than 300 hours total time had the highest estimated accident rate and pilots with more than 7000 hours had the lowest. The accident rate for pilots with less than 100 hours of actual instrument time was one-half that of pilots with more instrument time. The accident rate was lowest for pilots with less than 25 hours in 90 days and highest for pilots with more than 200 hours. (R. 2, p. 19, para. 3)

He considers himself at or just below the level of a professional pilot in aeronautical skill, knowledge, and experience. (R. 1, p. 6, No. 36)

On a scale of one (low) to six (high), he scores his skill and experience at four, his knowledge at five. (R. 6, p. 7, No. 36)

He considers the six hours of instrument experience within the preceding 6 calendar months adequate in maintaining a safe level of instrument proficiency. (R. 1, p. 6, No. 35)

He believes that maintaining recency of experience is a problem, and that the use of more simulators would solve this problem. (R. 6, p. 5, No. 17)

He is current on instruments, having logged at least 25 hours instrument in the last twelve months. He has at least 140 hours total instrument time logged, at least 60 of which are actual instrument in an airplane. (R. 1, p. 4, No. 10)

He has been a pilot in command in actual instrument weather conditions in the last six months. (R. 1, p. 4, No. 11)

### C. Experience Continued

20 - 24% of his time on instrument flight plans is in actual instrument conditions. (R. 1, p. 5, No. 27)

He has flown in a single engine aircraft in IFR, night VFR, and night actual IFR conditions. (R. 1, p. 6, No. 34)

He flies about once per week, on an IFR flight plan about every other week. (R. 1, p. 4, No. 9)

During the last twelve months, he has most frequently flown for business (not for hire) or personal reasons. (R. 1, p. 4, No. 18)

During the last twelve months, all flying and single pilot IFR flying was for personal (pleasure) or business (not for hire) purposes. (R. 6, p. 7, No. 34)

He has most often made ILS approaches in the last twelve months. (R. 1, p. 4, No. 17)

He has made an ILS approach in actual instrument conditions during the last twelve months. (R. 1, p. 5, No. 28)

During the last twelve months, the most frequent approach he has flown was an ILS approach with radar assistance available. (R. 6, p. 6, No. 25)

During the last 12 months, he has been rerouted or had to hold no more than twice and has not had to execute a missed approach or divert to an alternate. (R. 1, p. 6, No. 31)

During the last twelve months, he has (a) filed IFR ten times, (b) had to hold once, (c) not had to execute a missed approach, (d) been rerouted twice, (e) not had to divert to an alternate, (f) not had to ask for an altitude change due to icing, (g) asked for a route change due to thunderstorms once, (h) not had to declare an emergency, (i) not requested special handling. (R. 6, p. 7, No. 32)

During the last twelve months, he flew VFR and on an IFR flight plan more than four times per month, but in actual IFR conditions less than once per month. (R. 6, p. 7, No. 35)

SPIFR accident frequency, totals, causes, and trends have undergone little overall change since the previous study. (R. 7, p. 13, para. 1)

It appears that the operational problems being experienced by the SPIFR may be independent of experience. Although this hypothesis needs to be tested more thoroughly, it is suggested that if the

### C. Experience Continued

hypothesis were found to be valid then remedies to SPIFR operational problems do not lie in improving SPIFR capabilities through more training and experience. Rather, the nature of the SPIFR task should be changed through the redesign of cockpit systems and ATC procedures in handling the SPIFR. (R. 5, p. 35, No. 2)

A high percentage of SPIFR's are not experiencing any problems with the various activities, system's, and environments to which they are exposed during the conduct of a SPIFR flight. (R. 6, p. 10, No. 1)

Based upon this analysis, which reveals the relatively high commonality of response codes reported between categories of pilots of different experience levels, it appears that the operational problems experienced by the SPIFR are independent of experience. If this hypothesis is valid, then it is suggested that remedies to SPIFR operational problems do not lie in improving SPIFR capabilities through more training and experience. Rather, the nature of the SPIFR task should be changed through the redesign of cockpit systems and ATC procedures in handling the SPIFR. (R. 6, p. 55)

He is a 40 year old male. (R. 6, p. 7, No. 38)

Pilot overconfidence due to high instrument time and time in last 90 days. (R. 2, p. 19, para 13, problems)

Low pilot time in aircraft type. (R. 2, p. 19, para. 14, problems)

Pilot Characteristics assumed: Instrument Rated; Current Instrument Proficiency Biennial Flight Review; Experienced in Instrument Flight Rules, Federal Aviation Regulations; Experienced in Aircraft Type and Model; and No Co-pilot (R. 3, p. 4-3, para.1)

Commercial pilots were involved in 56 percent of the 335 accidents, however, the number of accidents per 100,000 private pilots was three times that of commercial pilots. Forty-six of the accidents involved professional pilots. (R. 2, p. 19, para 2)

Summary: The composite SPIFR pilot has about 2000 hours total time and 200-250 hours within the previous 12 months; and has 20-40 hours instrument time in previous 12 months. SPIFR pilot accidents averaged 3000 hours total pilot time. ILS approaches are most commonly made. Operational problems may be independent of experience.

D. Pilot Skill/Proficiency/Decision Making

He considers himself at or just below the level of a professional pilot in aeronautical skill, knowledge, and experience. (R. 1, p. 6, No. 36)

On a scale of one (low) to six (high) he scores his skill and experience at 4, his knowledge at 5. (R. 6, p. 7, No. 36)

He subscribes to USE and GS flight information publications, which are usually current. (R. 1, p. 5, No. 19)

He tends to use the published minimums on instrument approaches as his personal minimums. (R. 1, p. 5, No. 21)

He uses the published minimums on instrument approach procedures as his personal minimums. (R. 6, p. 6, No. 30)

If the weather were reported to be below minimums at his destination airport, he would not fly the approach. (R. 6, p. 6, No. 31)

He experiences little or some difficulty, but not much or extreme, in conducting IFR flights during departure, transition, and approach phases. (R. 1, p. 6, No. 37)

He believes that there are no navigation type problems. (R. 6, p. 5, No. 15)

He rates ILS, LOC, and VOR approaches as having little difficulty, ADF approaches as having some difficulty. (R. 1, p. 6, No. 32)

Landing phase operations, especially on the final approach segment. (R. 2, p. 19, para. 6)

He believes the reason for his flying performance deterioration mentioned in the previous question to be caused by lack of recent instrument flying experience. (R. 1, p. 6, No. 39)

Imprecise IFR navigation. (R. 2, p. 19, para. 9, problems)

Below minimums approaches. (R. 2, p. 19, para 10, problems)

Of the 335 SPIFR accidents there were 96 which occurred while the pilot was executing an ILS approach and 90 while executing a VOR approach. In general, the approaches which allowed lower descents had a higher percentage of accidents at night. (R. 2, p. 18, para. 4)

Single-pilot pilot error accidents are increasing at a rate of 3.5 accidents per year. This rate is three times the dual-pilot pilot

#### D. Pilot Skill/Proficiency/Decision Making Continued

error rate. There were 877 single pilot error accidents, 446 of which occurred during the landing phase. Of the 446, there were 335 on IFR flight plan. (R. 2, p. 18, para. 2)

During the daytime, he would go when light icing, light or moderate turbulence, heavy rain, scattered or broken thunderstorms, IFR over mountains, or IFR over water were reported to exist anywhere enroute. He would not go during the day if moderate icing, lines of thunderstorms, heavy ground fog or weather below minimums were reported. At night, he would go when light or moderate turbulence, scattered thunderstorms, or IFR over water were reported to exist anywhere enroute. He would not go at night if any of the other previously mentioned conditions were reported. (R. 6, p. 6, No. 29)

Improper IFR operations were given as a cause/factor in 170 of the 335 SPIFR accidents. In 104 of the improper IFR operations accidents fog was also a cause/factor and in 68 low ceiling was a cause/factor. Icing was a cause/factor in 56 accidents and fuel exhaustion was a cause/factor in 14. (R. 2, p. 18, para.3)

Weather data dissemination techniques and pilot understanding.  
(R. 2, p. 19, para. 11, problems)

Ten SPIFR Operational Problem Categories have been identified in the ASRS-2 database. In order of decreasing frequency of occurrence, they are: Pilot Allegations of Inadequate Service (30 percent), Altitude Deviation (20 percent), Improperly Flown Approach (15 percent), Heading Deviation (13 percent), Position Deviation (7 percent), Below Minimums Operations (6 percent), Loss of Airplane Control (3 percent), Forgot Mandatory Report (3 percent), Fuel Problem (2 percent), and Improper Holding (2 percent). (R. 5, p. 35, No. 1)

A pilot's "mind set" was a factor in altitude deviations, appearing in 68 percent of the occurrences. (R. 5, p. 36, No. 5)

Lack of pilot proficiency is apparent in improperly flown approach occurrences. In 22 percent of these occurrences, there was evidence that pilots did not understand when not to execute a procedure turn. (R. 5, p. 36, No. 6)

The pilot's lack of awareness of his position is an important factor in position deviation occurrences. (R. 5, p. 36, No. 7)

Takeoff below minimums occurrences were related to the pilot's cognitive processes. Landing below minimums occurrences probably could have been prevented by better preflight weather planning and more conservative decision making by the pilot. (R. 5, p. 36, No. 8)

#### D. Pilot Skill/Proficiency/Decision Making Continued

During an instrument approach in actual IFR conditions, he often encounters the "normal" IFR condition and has little difficulty with it. He seldom encounters minimum ceiling and/or visibility, light or moderate icing, light or moderate turbulence, or nonroutine ATC instructions; when he does, he experiences little difficulty in handling the situation. He seldom encounters scattered or broken thunderstorms, or strong winds; when he does, he has some difficulty in handling the situation. (R. 6, p. 6, No. 23)

He believes the most common errors made by instrument pilots are:

- (1) not knowing personal limitations.
- (2) not planning ahead.
- (3) allowing skills to deteriorate. (R. 1, p. 7, No. 40)

In his opinion, inaccurately assessing and exceeding one's personal limitations and capabilities is the most common error made by IFR single pilots. (R. 6, p. 4, No. 3)

Pilot judgment and response problems have primary elements of:

- Excessive/impeding procedural requirements
- Training/proficiency flight infractions
- Limitations due to limited avionics (R. 4, p. 13, para. 2)

ATC and pilot communication problems have primary elements of:

- Misunderstanding of instructions
- Frequency congestion
- Excessive frequency changes
- Excessive/impeding procedural requirements (R. 4, p. 13, para. 4)

Communications Problems include: Communications Channel Congestion (R. 3, p. 4-20 and 4-46, para. 4.2.2 and 4.3.1); Communications Errors, Omissions and Dropouts (R. 3, p. 4-20, para. 4.2.2); and Access to Evolving Ground Data Base (R. 3, p. 3-2, para. 3.1 and 3.2)

Fuel mismanagement and inadequate fuel quantity. (R. 2, p. 19, para. 12, problems)

Summary: The SPIFR pilot considers his/her skill and knowledge at or just below the professional pilot; uses published minimums as personal minimums; and has different weather limitations for day and night. Common errors are not knowing personal limitations, not planning ahead; allowing skills to deteriorate. A large number of single-pilot pilot error accidents are during landing phase and on an IFR flight plan.

## E. Workload/Distracton

Loss of airplane control generally followed the pilot being distracted. Even relatively experienced pilots lost airplane control. (R. 5, p. 36, No. 9)

Depending upon what determinant is used to assess workload, between one-quarter and three-quarters of the occurrences involved workload as a causal factor. (R. 5, p. 36, para. 1)

Pilot Factors reflecting on operational problems include: High Workload in Critical Flight Phases (R. 3, p. 4-24; para. 4.2.4); High Workload in High Density Environments (R. 3, p. 4-24, para. 4.2.4); and Potential Workload Impacts of New ATC Features. (R. 3, p. 3.2, para. 3.1 and 3.2)

High workload, especially in twin engine aircraft. (R. 2, p. 19, para. 15, problems)

He almost never receives assistance from someone during an IFR flight. When he does receive assistance, it is from another instrument rated pilot who is not a required copilot. (R. 1, p. 6, No. 33)

He seldom has someone assist him in the airplane during a flight in actual IFR conditions. If he does, the person is a pilot but does not have an instrument rating, and is not a required copilot. (R. 6, p. 6, No. 26)

He would often prefer to have someone assist him in the airplane during flight in actual IFR conditions. (R. 6, p. 6, No. 27)

He believes heading control to be the aspect of flying performance to deteriorate first as a "normal" IFR flight becomes more difficult because of IFR conditions. (R.1, p. 6, No. 38)

As a "normal" IFR flight becomes more difficult because of workload, ATC communications and clearance interpretation is the aspect of flying performance which is most likely to deteriorate.

He attributes this deterioration to getting too busy with other tasks, having his attention divided, and not having enough time. (R. 6, p. 6, No. 22)

Summary: The SPIFR pilot seldom has someone to assist during IFR flights. Heading control deteriorates first; and ATC communications and clearance interpretation is most likely to deteriorate with increased workload.

F. Weather/Condition of Light

He will usually file IFR if his destination weather is forecast to be ceiling 5000 feet or less, visibility 5 miles or less. (R. 1, p. 5, No. 23)

He seldom or never cancels an IFR flight plan upon reaching VFR conditions after departing an airport in IFR weather. (R. 1, p. 5, No. 24)

He seldom or never files an IFR flight plan before departing on a flight to be conducted entirely in the daytime in good VFR conditions. (R. 1, p. 5, No. 25)

He seldom or never files an IFR flight plan in flight. (R. 1, p. 5, no. 26)

Unforecast and unanticipated weather was the most frequent unanticipated thing which happened during his last three flights as an IFR single pilot (R. 6, p. 4, No. 6)

Better, more up to date weather information/briefings is the one change in the system which would make his IFR single pilot flight operations easier. (R. 6, p. 4, No. 7)

In obtaining preflight aviation weather information, he almost always makes a direct call to FSS; often uses TV weather; seldom visits FSS, seldom uses PATWAS or TWEB; and never uses "AM Weather" or the newspaper. (R. 6, p. 5, No. 11)

He believes that the reliability of FSS weather information is a problem, but cannot recommend a solution to the problem. (R. 6, p. 5, No. 19)

In obtaining inflight aviation weather, he almost always uses ATIS; often uses direct FSS communication of EFAS; seldom uses ARTCC or TWEB. (R. 6, p. 5, No. 12)

Weather data dissemination techniques and pilot understanding. (R. 2, p. 19, para. 11, problems)

He will probably go on an IFR flight if light icing or scattered thunderstorms are reported anywhere enroute. He probably will not go if heavy ground fog is reported. (R. 1, p. 5, No. 22)

He believes icing to be a weather problem. (R. 6, p. 5, No. 20)

F. Weather/Condition of Light Continued

The one most serious problem which he has encountered in his experience as an IFR single pilot has been icing. (R. 6, p. 4, No. 4)

He handled the problem by obtaining an ATC clearance to a different altitude/heading. (R. 6, p. 4, No. 5)

Flight in icing conditions when the aircraft is not deicing or anti-icing equipped. (R. 2, p. 19, para. 8, problems)

Improper IFR operations were given as a cause/factor in 170 of the 335 SPIFR accidents. In 104 of the improper IFR operations accidents fog was also a cause/factor and in 68 low ceiling was a cause/factor. Icing was a cause/factor in 56 accidents and fuel exhaustion was a cause/factor in 14. (R. 2, p. 18, para. 3)

He has had no need to cancel an IFR flight during the last 12 months. If he has, it was because of weather beyond his aircraft/equipment capability. (R. 1, p. 5, No. 20)

During the last twelve months, when he has had to cancel an IFR single pilot flight just before planned departure it was because of weather beyond his personal limitations. (R. 6, p. 6, No. 28)

Of the 335 SPIFR accidents there were 96 which occurred while the pilot was executing an ILS approach and 90 while executing a VOR approach. In general, the approaches which allowed lower descents had a higher percentage of accidents at night. (R. 2, p. 18, para. 4)

Of the 335 SPIFR accidents there were 96 which occurred while the pilot was executing an ILS approach and 90 while executing a VOR approach. In general, the approaches which allowed lower descents had a higher percentage of accidents at night. (R. 2, p. 18, para. 5)

There were 152 SPIFR accidents where the aircraft collided wings level with trees or with the ground. In 63 percent of these the visibility was one mile or less and in 70 percent it was dark. (R. 2, p. 18, para. 4)

There were 139 SPIFR accidents which occurred during final approach. In these cases, the number of accidents doubled for every mile decrease in visibility. The initial approach phase had the highest fatality rate with .63 fatal accidents per accident. There were no fatalities in the leveloff/touchdown or rollout accidents. (R. 2, p. 18, para. 6)

## F. Weather/Condition of Light Continued

There were 240 SPIFR accidents which occurred in fog, 180 in the dark, and 62 in below minimums weather. Air taxi-passenger and ferry operations had the highest below minimums accident rates. (R. 2, p. 18, para. 7)

Below minimums operations. - Seven below minimums operation occurrences were identified in the SPIFR document set, six involving SMA and one SMT. A below minimums operation is one in which the actual weather is lower than the minimums prescribed for the particular operation and a pilot performs a takeoff (2 occurrences), or lands an airplane (4 occurrences), or must divert to an alternate (1 occurrence). The characteristics of the below minimums operations are Table 15. (R. 5, p. 24, para. 3)

Low visibility operations at night due to fog and low ceilings. (R. 2, p. 19, para. 7 problems)

The disparity between day and night SPIFR accident rates. Out of 5,416 SPIFR accidents from 1964 to 1975 which involved pilot error, only 14 percent occurred at night. Based upon our estimate of night time activity (12.8 percent of overall activity) derived from the "General Aviation Pilot and Aircraft Activity Survey", it appears that SPIFR accident rates are unaffected by the condition of light while SPIFR approach/landing phase accident rates are magnified by 10 fold. (R. 7, p. 42)

Problems Areas and Primary Elements include: IFR-VFR conflicts relating to aircraft proximity at breakout and IFR flight in VFR and MVFR conditions (R. 4, p. 13, para 5)

Marginal and/or instrument meteorological conditions are presumed to exist. (R. 3, p. 4.3, para. 3)

The primary role of the FAA is to be the provider of ATC services. Thus it is in character that the thrust of the FAA's own modernization program is to improve the efficiency with which such services are provided, without necessarily concentrating on the efficiency of the services themselves or the particular needs of the various classes of operators. The resulting ATC facilities modernization plans for the most part will result in continued, or increased, operating costs for GA IFR operators while not significantly improving the efficiency of their operations. Potential exceptions include the program for improved weather data collection and distribution, the ATARS concept, factors improving airport capacities, and area navigation (which will be implemented very slowly. (R. 3, p. 6-1, para. 3)

Summary: Improved timely weather reports/briefings are desirable. Icing is the most serious weather problem. Usually the

F. Weather/Condition of Light Continued

SPIFR pilot files IFR if his destination is forecast to be ceiling 5000 feet or less and visibility 5 miles or less. Approaches which allow lower descents; actual visibility one mile or less; and darkness account for a large percentage of SPIFR accidents.

G. Air Traffic Control

Ten SPIFR Operational Problem Categories have been identified in the ASRS-2 database. In order of decreasing frequency of occurrence, they are: Pilot Allegations of Inadequate Service (30 percent), Altitude Deviation (20 percent), Improperly Flown Approach (15 percent), Heading Deviation (13 percent), Position Deviation (7 percent), Below Minimums Operations (6 percent), Loss of Airplane Control (3 percent), Forgot Mandatory Report (3 percent), Fuel Problem (2 percent), and Improper Holding (2 percent). (R. 5, p. 35, No. 1)

The most frequently identified SPIFR Operational Problem was a pilot's allegation of inadequate service: Three-quarters of such allegations are deemed reasonable. (R. 5, p. 36, No. 4)

He believes that ATC demands are a problem during instrument approaches and that better controller awareness about the nature of the GA SPIFR operation would solve this problem. (R. 6, p. 5, No. 13)

He believes that too many communications frequency changes are a problem, and that the system should be designed so as to require fewer frequency changes. (R. 6, p. 5, No. 21)

Controller judgment and response problems include: excessive/impeding procedural requirements; training/proficiency/experience related mistakes; and equipment operational problems. (R. 4, p. 13, para. 1)

ATC intrafacility and interfacility conflicts include: internal communication problems; hand-off problems; mixed departure and arrival conflicts; and equipment operational problems. (R. 4, p. 13, para. 3)

ATC and pilot communication problems include: misunderstanding of instructions; frequency congestion; excessive frequency changes; and excessive/impeding procedural requirements. (R. 4, p. 13, para 4)

## G. Air Traffic Control Continued

He believes that the Federal Aviation Regulations and ATC procedures are too complex and excessive, and that they should be simplified. (R. 6, p. 5, No. 16)

Communications operational problems include: Communications Channel Congestion (R. 3, p. 4-20, 4-46, para. 4.2.2 and 4.3.10; Communications Errors, Omissions and Dropouts (R. 3, p. 4-20, para. 4.2.2); Lack of Tower or Off-Hours Services (R. 3, p. 4-18, 4-20, 4-51, 4-34, para 4.2.1, 4.2.2, 4.4.4 & 4.3.5); and Access to Evolving Ground Data Base (R. 3, p. 3-2, 3-8, para. 3.1 and 3.2)

Summary: SPIFR pilots believe they receive inadequate service from ATC; that there are too many frequency changes; and there are too many ATC demands during approaches. Controller intrafacility and interfacility conflicts may contribute to the SPIFR operational problem.

## H. Safety, Efficiency, Reliability

Safety and Efficiency are present in SPIFR Operational Problem occurrences. Half of the occurrences involved an act or condition likely to lead to grave consequences, and one-third involved an act or condition of ignorant or imprudent deviation from acceptable procedures. In more than one-third of the occurrences, the efficiency of IFR flight was affected. (R. 5, p. 35, No. 3)

Mission Reliability and Efficiency Operational Problems include: Flight Planning/Information Availability (R. 3, p. 4-18, para. 4.2.1); Flight Delays in Dense Terminal Areas (R. 3, p. 4-22, 4-26, 4-28, para. 4.2.3, 4.3.1, 4.3.2); Lengthy Delays/Diversions in IMC (R. 3, p. 4-33, para. 4.3.3); Limited Availability of Landing Aids (R. 3, p. 4-34, para. 4.3.4); Routing Inefficiencies (R. 3, p. 4-36, para. 4.3.6); Enroute Weather Avoidance Delays (R. 3, p. 4-18, para. 4.2.1); and Low Density Area Delays Due to Lack of Tower (R. 3, p. 4-22, 4-34, para. 4.2.3 & 4.3.5).

Safety Operational Problems include: Maintaining Required Separation (R. 3, p. 4-37, para. 4.3.7); Weather-Related Accidents (R. 3, p. 4-3-9, para. 4.3.8); Growing Airborne Alert Environment Complexity (R. 3, p. 3.2, para. 3.1 & 3.2) and Final Approach Accidents (R. 3, p. 4-43, para. 4-3-9).

In light of the above factors, the cost to a GA IFR operator to improve his mission reliability on his own is very high and the payoff which results is often insufficient to cover that cost. Likewise, the cost to an airport operator to provide the ground

## H. Safety, Efficiency, Reliability Continued

segments of these ATC services is very high utilizing present technology, and so is typically justified only at airports with significant air carrier traffic, or very large GA airports. (R. 3, p. 6.2, para. 2)

The tendency of the ATC system to control more and more airspace as time passes provides improved safety to controlled aircraft but at a general price of reduced operating efficiency for those aircraft. Also such trends tend to drive many operators out of that airspace, actually degrading their safety of operation by compressing them in a smaller amount of airspace. A potential solution to this problem is to improve the means by which aircraft operators can manage their own separation and ATC procedures, either through air-derived collision avoidance sensors, or through the display of ground-derived traffic data. (R. 3, p. 6-2, para. 3)

A comprehensive, well planned attack on the operational problems of GA IFR operators is needed to provide viable and economical solutions in order that such a valuable transportation resource can develop to the benefit of all. This program will include research which not only addresses the technology development issues, but the operational procedures issues as well. (R. 3, p. 6-3, para. 1)

The primary role of the FAA is to be the provider of ATC services. Thus it is in character that the thrust of the FAA's own modernization program is to improve the efficiency with which such services are provided, without necessarily concentrating on the efficiency of the services themselves or the particular needs of the various classes of operators. The resulting ATC facilities modernization plans for the most part will result in continued, or increased, operating costs for GA IFR operators while not significantly improving the efficiency of their operations. Potential exceptions include the program for improved weather data collection and distribution, the ATARS concept, factors improving airport capacities, and area navigation (which will be implemented very slowly). (R. 3, p. 6-1, para. 3)

ATC plans for expansions to positive controlled airspace through reductions in the altitude "floor" and through expansions of the number of TCA's tends to drive general aviation out of that airspace, and in particular, drives lower capability IFR operators away while, possibly, attracting the higher capability IFR operators (45). Unfortunately for the lower capability GA IFR operator he is therefore being driven away from the very services he needs so desperately. (R. 3, p. 6-2, para. 1)

## H. Safety, Efficiency, Reliability Continued

Summary: Safety is a concern that weaves its way through all of the reports. A common goal among agencies and authors is to improve safety. Efficiency and reliability are usually inferred. The three concerns of safety, efficiency and reliability are frequently interdependent but an improvement in one does not necessarily improve another.

### I. Aircraft

He flies a complex (having retractable gear and controllable propellor) single or multiengine aircraft, produced since 1965, having a cruise speed of 150-159 knots, and an approach speed of 100-109 knots. (R. 1, p. 3, No. 1)

He flies a single engine airplane (four places and over), having retractable gear and controllable propellor, produced since 1974, having a cruise speed of 140-149 knots, and an instrument approach speed of 100-109 knots. (R. 6, p. 4, No. 1)

His aircraft has two 360 channel transceivers, two VOR/LOC receivers, at least one glide slope receiver, ADF and marker beacon receivers, and a transponder. It is equipped with pitot heat and an autopilot with at least a roll capability. (R. 1, p. 3, No. 2)

His airplane is equipped with two communications transceivers, two VOR/LOC receivers, one glide slope receiver, an ADF and a marker beacon receiver, transponder with altitude encoder, and a DME receiver. It has an autopilot with roll and heading capability. It is also equipped with pitot heat and a headset boom microphone. (R. 6, p. 4, No. 2)

He had much to say about the selection of the aircraft. (R. 1, p. 3, No. 4)

Given a single engine airplane with one NAV/COM/LOC, and \$7,500 he would purchase the following additional equipment: transponder, 360 or 720 channel transceiver, glideslope receiver, marker beacon receiver, second VOR/LOC receiver, pilot heat, ADF receiver and an altitude encoder. (R. 6, p. 4, No. 8)

His aircraft is most likely to be company owned. (R. 1, p. 3, No. 3)

## I. Aircraft Continued

Aircraft used for business or air transportation functions are likely to be better equipped. (R. 6, p. 12, No. 4)

More total SPIFR hours are being flown in airplanes appearing with greater frequency. The more complex the airplane, the greater the average hours flown. The turbojet sample is too small for meaningful results. (R. 6, p. 10, No. 2)

The more sophisticated the airplane, the more likely it is to be used in a business or air transportation for hire function. (R. 6, p. 11, No. 3)

He believes that poor stability is a problem in airplane stability and control and that the use of an autopilot would solve this problem. (R. 6, p. 5, No. 18)

He believes that inadequate lighting is a cockpit environment problem, and that better lighting would solve this problem. (R. 6, p. 5, No. 14)

Growing vehicle control complexity (R. 3, p. 4-49, para. 4.3.11)

Fifty-eight percent of the SPIFR accidents occurred in twin engine aircraft whereas an estimated 45 percent of the IFR operations were conducted in twins. (R. 2, p. 19, para. 4)

Summary: The SPIFR pilot flies a retractable gear, controllable propellor about 7 years old or newer. The aircraft has two 360 NAV/COM's with one glide slope receiver, ADF, marker beacon receiver, transponder, pitot heat, and at least a simple autopilot.

## J. Airport

He originates his IFR flights from an airport which has an ILS or a VOR approach. (R. 1, p. 4, No. 16)

He operates IFR most often within a radius of 400 nm of his home airport. (R. 1, p. 5, No. 29)

The one way distance of this longest non-stop IFR flight during the last 12 months was 500 nm or less. (R. 1, p. 6, No. 30)

He flies from one of the higher aviation activity states, having a high percentage of the nations's more than 13,000 airports and 210,000 general aviation aircraft. (R. 6, p. 6, No. 24)

## J. Airport Continued

Future Traffic Growth Rate in High Density Areas (R. 3, p. 2-10, para. 2.2)

At present GA IFR operations constitute a major segment of the U.S. air transportation system. Projections show that in the future, GA IFR operations will grow to the point where they will dominate air carrier operations in terms of sheer numbers. This is true in high density urban areas as well as outlying areas. The major finding of this study is that the GA IFR operator's problems are very serious, and will get much worse. (R. 3, p. 6-1, para. 2)

The primary role of the FAA is to be the provider of ATC services. Thus it is in character that the thrust of the FAA's own modernization program is to improve the efficiency with which such services are provided, without necessarily concentrating on the efficiency of the services themselves or the particular needs of the various classes of operators. The resulting ATC facilities modernization plans for the most part will result in continued, or increased, operating costs for GA IFR operators while not significantly improving the efficiency of their operations. Potential exceptions include the program for improved weather data collection and distribution, the ATARS concept, factors improving airport capacities, and area navigation (which will be implemented very slowly). (R. 3, p. 6-1, para. 3)

Summary: General Aviation IFR is a major segment of the transportation. Flights generally originate from airports with an ILS or VOR. The SPIFR pilot most often operates IFR within 400 miles of home airport.

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16. Abstract  A review of seven research studies pertaining to Single Pilot IFR (SPIFR) operations was performed. Two studies were based on questionnaire surveys; two based on National Transportation Safety Board (NTSB) reports; two were based on Aviation Safety Reporting System (ASRS) incident reports, and one report used event analysis and statistics to forecast problems. The results obtained in each study were extracted and integrated. Results were synthesized and key issues pertaining to SPIFR operations problems were identified. The research that was recommended by the studies and that addressed the key issues is catalogued for each key issue.					
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